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SCIENCE

VOL. LXIX MARCH 8, 1929 No. 1784

CONTENTS

Meteorology's Frozen Assets: DR. W. J. HUMPHREYS 255

High Frequency Radiation of the X-ray Type: SIR ERNEST RUTHERFORD 259

Scientific Events:
The National Research Council of Italy; A Belgian Royal Colonial Institute; Plant Exploration in Madagascar; A Proposed National Monument in the Bad Lands of South Dakota; The World's Engineering Congress; President Hoover on Education and Public Health 263

Scientific Notes and News 266

University and Educational Notes 269

Discussion:
Biological Publication in America: PROFESSOR MAYNARD M. METCALF. *Evolution:* DR. AUSTIN H. CLARK. *Amia from the Cretaceous:* DR. DAVID STARR JORDAN. *Misuse of Scientific References in Commercial Advertising:* M. BODANSKY. *Importation of Cinematographic Films:* PROFESSOR WARREN H. LEWIS. *Reply to Professor Willcox:* PROFESSOR EDWARD V. HUNTINGTON 269

Special Correspondence:
Geological Work in Tonga and Fiji: DR. H. S. LADD and DR. J. E. HOFFMEISTER 272

Scientific Books:
Yard's Our Federal Lands: PROFESSOR HENRY B. WARD. *Braun-Blanquet's Pflanzensoziologie; Grundzüge der Vegetationskunde:* PROFESSOR JOHN W. HARSHBERGER 273

Reports:
Vitamin B Terminology: PROFESSOR R. ADAMS DUTCHER 276

Scientific Apparatus and Laboratory Methods:
An Improved Method for Sealing Microscopic Mounts: WILLIAM W. DIEHL 276

Special Articles:
Crystalline Turanose: DR. C. S. HUDSON and DR. EUGEN PACSU. *The pH of the White as an Important Factor Influencing the Keeping Quality of Hens' Eggs:* PROFESSOR PAUL F. SHARP 278

Science News x

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METEOROLOGY'S FROZEN ASSETS[1]

IN the business and financial world frozen, or unavailable and unsalable, assets are almost as bad as no assets at all. A bank, for instance, may be forced to buy in a large amount of real estate at a foreclosure to avoid losing wholly loans that appeared entirely conservative when made. But by so doing its liquid or cash assets, without which it can not do business, are to that extent rendered unavailable; and its troubles might become serious if too many depositors asked for cash—for cash is what they want and not a vacant lot, perhaps, or other piece of stagnant property. Similarly, the farmer may have tobacco, cotton or grain in a warehouse but be quite unable promptly to sell it. His capital is frozen, and if, as often happens, he borrowed on it, his creditor has a frozen debt and may, therefore, be unable to meet on time obligations that he in turn had assumed; nor indeed does trouble usually end with the third or even fourth removal from the first cause. In short, frozen assets are of no value except when, and to the extent that, they are readily convertible into liquid assets; rather are they liabilities, for they all cost something to keep—taxes at least.

Unfortunately, knowing the pinch of poverty in the midst of plenty—of possessing frozen capital that does no one any good—is not confined to the business world. Science, too, and every branch of it, is far less productive of the good it could do because so many of its valuable assets are rigidly frozen—so many investigations that deal directly with each particular science, and especially so many more that deal with it indirectly, are lost for years, if not forever, in the jungle of journals and tangle of tongues. In this sense meteorology, to be specific and to come at once to the subject under consideration, is actually one of the poorest of all sciences. Its assets, indeed, are amazingly great and rapidly accumulating, but they are frozen to such a depth and breadth that only a Hercules could make them liquid—available for power and light, and able, besides, to change the forlorn desert of our ignorance to an inspiring field of knowledge.

Of course, it occurs to every one that the thousands of observations of temperature, pressure, humidity, wind velocity, and other weather elements, made every

[1] Address of the president of the American Meteorological Society, New York City, December 27, 1928.

day and the world over, are quickly submerged by the new thousands of the next day, and the next and the next, month after month, and year after year, without end.

On first thought it might seem that such a mass of details is both useless and self-destructive, like the giant that grew so big (not so very big either, a height of thirty feet would do the trick) that when down he couldn't get up, but it is neither the one nor the other, neither useless nor unmanageably vast. Just as tens of thousands of telegrams are sent daily, merely to give information as to where certain trains happen to be at the moment and when they may be expected to arrive at particular stations, so, too, many thousands of weather observations are made every day for the express and sufficient purpose of locating storms and other atmospheric states and conditions, to the end that everywhere, within the region served, the coming weather may be foreseen, for at least a day or two, with a fair approach to certainty. And let me say, parenthetically, that fortunately this approach can be, and is, closer and closer to perfection almost in proportion to the severity of the storm and consequent importance of the forecasts; save alone, to be frank, in the case of that erratic weather demon, the tornado. This temporary need is more than sufficient to justify the taking of continuous automatic registrations of the weather elements and of numerous eye observations. But why then store away the records thus obtained, we may be asked, in ever-increasing numbers? Because an urgent need may arise at any time to know exactly what the weather was at a particular time and place; information that such records alone can supply so clearly and so definitely as to preclude all questions and every quibble. But this is not all. From time to time some one needs the detailed weather data of a particular place or of several, or even many, places for a special study he is making of a local climate or the relation, it may be, of that climate to something else, and nothing but the original records will serve his purpose.

As these data are accumulated they also are summarized in such manner as to meet all the more common needs for them. But other needs, and there are many such, are apt to require a different grouping of the data or even to require the data themselves in greater detail. Here again the student can only be referred to the original records. His special needs can not be anticipated—he could not have anticipated them himself—and indeed they often change even during the progress of his work. And the probability that the next student of these data will want them grouped in still another way is so great as to be well-nigh a certainty. Hence it is that in spite of the fact that the millions upon millions of weather data are classified and expressed in terms of averages, extremes, and otherwise, so as to meet most ordinary needs, the complete original records are, and must be, kept for the endless varieties of occasional uses they alone can serve.

All this applies fully only to observations at fixed stations and to those countries that have well-established weather services. These meteorological assets, vast and ever increasing, are fairly liquid—moderately available to every one. They would be distinctly more limpid, however, if all were directly intercomparable, all expressed in the same units, assembled in the same manner and covered the same periods of time.

In respect to all other land areas, however, and they are many and vast, the situation is radically different, as it also is for any time more than a few decades back in even those countries that now collect abundant weather data and prepare lengthy climatological tables and digests. Nevertheless, great quantities of widely scattered meteorological data recently have been recorded in regions that even yet make no official weather reports, and other large amounts were recorded in the more fortunate countries before their present services were established, all of which, the recent and the older, and from whatever country, would be very valuable if readily obtainable. But they are not readily obtainable by any one, and by the great majority of those who presumably would make good use of them practically not obtainable at all. They are scattered through many thousands of books, reports, journals and casual publications, in a maze of tongues and a jumble of units. Furthermore, they exist collectively in very few libraries, perhaps half a dozen, at most, in the entire world. Essentially, these assets are rigidly frozen. Little streams trickle from them now and then as from a glacier, but it would take great ardor and many a hot summer to liquefy the whole mass and so warm the soil as to prevent further accumulation in the frozen form.

Again, marine meteorology has furnished, and is furnishing, oceans, if one may use that word in this connection, of data—Arctic oceans, for in great measure they are all frozen. These data are unsatisfactory in many respects. They are obtained here, there and yonder and not, like land data, at fixed places; they consist mainly of eye readings made at certain intervals, with nothing between, and with instruments that seldom, if ever, are, or can be, as satisfactorily installed as land instruments. Finally, vast areas of the oceans are so little traversed as to be practically

unknown meteorologically. It therefore is uncertain how much labor should be spent in so assembling and publishing this material as to render it readily available to all who may need it. At present these assets also are in great measure frozen. A portion of the mass easily could be made liquid, but some of it is so difficult of access that it probably is not worth the fuel it would take to melt it out. But this is no excuse for leaving it all frozen. As much of it as practicable should speedily be rendered liquid, and then the necessary precautions taken to prevent any future freezing over.

The foregoing is, perhaps, too general to excite enough interest to get results of any kind beyond a sleepy nod of assent, like the generalized confession of doing things we ought not to do and leaving undone those we should do. Particulars arouse more concern on the one hand, and curiosity on the other, and stand a better chance of having something done about them. Hence, a few specific examples of meteorology's frozen assets will be cited, assets that it would be eminently practicable to liquidate, and exceedingly worth while.

Every native of the temperate and higher latitudes is familiar with the snowflake. Occasionally, too, some one discovers for himself the snow crystal, especially when the temperature happens to be so low that the crystals remain separate and distinct and not stuck together in tufts of varying sizes as usually is the case when the temperature is but little below the freezing point. But when this observing individual does discover the snow crystal he seldom gives to it more than a passing admiration. Once in a long while some unusually inquisitive person, trained to "see" the things he looks at, examines the snow crystals closely enough to become convinced that while their general pattern appears to be the same, there seem to be two or three different varieties, maybe more. Among these few, in turn, of the more closely observant, there is but one who became so fascinated with the beauties of the snow crystal that he gave to it the ardor of the lover and the patience of the scientist. And so it has come about that his careful search of snow after snow, winter after winter, for a generation or more, among the northernmost of our New England mountains, has revealed not just three or four crystal varieties, but many hundreds of forms, all based on the one fundamental hexagonal pattern. Not only did he find this great multiplicity of kinds, but also he skilfully obtained beautiful microphotographs of them, and thereby made it possible for others to share at leisure and by the comfortable fireside the joys that hour after hour bound him to his microscope and his camera in an ice-cold shed. Of course some of these pictures have been reproduced in journals and some have been used as art patterns and suggestions, but there are, roughly, 4,000 of them in all, and the knowledge they contain and the art inspiration they possess both are, in the main, only frozen assets. This great wealth of material lies unused in the keeping of the patient genius who accumulated it. On any day so simple and so common a thing as a carelessly discarded cigarette or so inevitable an event as the snapping of the thread of a single life may indeed destroy utterly or scatter to the winds this unique collection of a lifetime.

Here is a rare opportunity for some one who wishes to contribute to uplift and progress. It would cost no more than a single stylish limousine, and much—perhaps even all, or more—would be returned in dollars and cents, and a thousandfold returned in the consciousness of well-doing. It would not be an expensive proposition at all, only a few thousand dollars, to reproduce in half-tone, several to the page, every one adjudged sufficiently distinctive of these snow crystal pictures. The accompanying text need not be long; twenty-five pages at most. The whole should be put together in one book of convenient size and pleasing appearance, and sold at a reasonable cost. Thus would be made liquid—readily available to the scientist, the artist and the layman—the meteorological assets, now mostly frozen, and in danger of being forever lost, patiently accumulated over many years by that rare and kindly genius, W. A. Bentley, of Jericho, Vermont.

No doubt any one familiar with meteorology can cite specific cases of frozen assets, and it is to be hoped that each will do so on every proper occasion, and himself do what he can to better the unfortunate condition. But let me suggest one thing in this connection that must seem Utopian, and yet a thing which I know to be within comparatively easy reach of realization. The great library at the central office of the U. S. Weather Bureau contains almost 50,000 volumes, and receives every journal, the world over, that deals with meteorology or any kindred subject. Of course an excellent and up-to-date card catalogue of all this material makes it as readily available as are the books and journals of our largest libraries and greatest institutions. But a card catalogue, though indispensable, is for all that a cold and lifeless thing, solitary, bulky and immovable. How exceedingly helpful it would be if in addition to this invaluable library guide we also could have an encyclopedic meteorological dictionary that listed every one of the thousands of words, many of them in no dictionary, that has air, weather or climatic significance; a work that gave the origin of these words,

wherever known, the sense or senses in which they have been and are used, with citations of place and author, and, finally, competent, *critical* references to the best literature in which they occur. As stated above, this seems altogether too good a thing to be realized. Well, it is in the making, and very far along at that. Even in its incomplete form it is extremely valuable, and I base this assertion on the abundant use I have been kindly permitted to make of it. I refer, of course, to that super card-catalogue which the indefatigable, accommodating and scholarly librarian of the U. S. Weather Bureau, Mr. C. F. Talman, has been accumulating for nearly two decades. It is a huge undertaking, but the material already assembled on many thousands of large dictionary cards, and to which additions are made daily, has already proved its worth. It is constantly consulted in the reference work of the library; has often been drawn on in supplying material for dictionaries, handbooks and encyclopedias, and furnished the material for the meteorological glossary in the Weather Bureau's "Instructions to Marine Meteorological Observers"—the best glossary of its kind extant, and yet the merest and most condensed sample of what the complete work would be like.

It would cost a little to liquidate this frozen asset, perhaps $25,000, and it would take at least two or three years, and more likely five, to do it, but it would be money extremely well spent, so far as the benefits to meteorology are concerned, and some of the cost would come back by way of sales of the publication. But such a dictionary would be out of date, some may insist, as soon as published. Certainly it would be out of date to some extent, just as all dictionaries and all other works of reference necessarily are. The logic of that situation is not to do nothing, but to have the material as nearly up to date as practicable at the time of first publication, and then day by day, as occasion may suggest or necessity require, accumulate notes and manuscript for a new edition.

To complete this work would be a big labor, and its publication a little expensive, but I can say with that assurance that comes from experience that few things indeed in the field of meteorology would so multifoldly reward the labor and the cost its completion would require.

The most valuable of meteorology's frozen assets and the part most urgently needed is that which treats the subject as a pure science—the theoretical and, in great measure, highly mathematical books, monographs and innumerable papers that discuss this or that particular phenomenon or group of phenomena. The progress of meteorology as a science depends, in the first place, mainly on the production of such papers, and, in the second place, upon the orderly assemblage in convenient book form of the substance of all these innumerable contributions.

These books—there is material enough for several—should not be mere translations of originals or assemblages of original articles, but treatises on the several branches or phases of meteorology based on a clear understanding of all contributions to it.

A very large percentage of these contributions, especially of the more important ones, necessarily are in the concise language of the mathematician. This makes them difficult and tedious reading, and there is no help for it, for there is no other language by which these ideas can be so tersely expressed and with such exact delimitation as certainly will exclude everything else—no other language by which, concerning such matters, it is possible to tell in terms of the premises, the truth, the whole truth, and nothing but the truth, nor other way rigidly to test the premises themselves, and if they are true to deduce therefrom additional truths often even of a kind totally unsuspected. It is only this type of meteorology, the physical and mathematical discussion of the air and its ways, that can or should command the serious attention and respect of our better educational institutions. Of course there still will be abundant room and necessity for non-mathematical, or commonsense, reasoning, for always there are important phenomena which we can not yet express in terms of precise, inclusive and solvable equations. Nevertheless, mere descriptive meteorology is pretty certain to be regarded as mostly talk, and often mighty loose talk at that. Meteorology, however, has the frozen assets which, if made properly liquid, then would command the highest respect of those who should teach this subject, mainly physicists, especially those that have neither a desire nor the occasion to shun mathematics; but it is obligatory that the meteorologists who have access to this mass of crude material first get it into form for the physicist to use.

I have tried, as some may know, to practice in this case what I preach. But let me say that keeping in sight, or even wireless range, of the procession is a hopeless task for any one individual. Furthermore, all that has yet been done, both in this country and abroad, falls very far short of presenting the air and its ways in that mathematical elegance and accuracy that even now is possible, and which, if done, would stimulate tremendously further study and research. I, for one, had begun to be hopeful that systematic digests of mathematical meteorology soon would begin to appear, for we had the man, Mr. E. W. Woolard, who had the rare native ability, the

exceptional training and the many years of accumulated acquaintance with that difficult subject absolutely essential even to trying to do anything with it. But, for the present, at least, that most hopeful promise is lost to us, and I see nothing on the horizon just now that offers any real prospect of the early thawing out of these vast, frozen, mathematical assets of meteorology.

Perhaps some one may ask, and it would be a perfectly proper and natural question, what use could be made of this wilderness of symbols if we had it—this strange and difficult language that very few meteorologists can read, or ever, in their daily work, have any occasion to read.

For one thing, and a more than sufficiently important one, it could be presented to our leading educational institutions as convincing proof that meteorology is, indeed, a difficult branch of physics worthy to take rank among the intellectual nobles, instead of being a little kitchen scullion, as so many now seem to regard it, in that most populous household called geography. Having thus established both its respectability as a college subject, and difficulty of mastery, it inevitably would attract some of the better students, who in turn would advance it to still higher stages. Thus the service of meteorology would become recruited, in part, from that hardworking upper 10 per cent., and not, as otherwise necessarily, from those who, in this particular at least, only toy with studying by taking a mere descriptive subject of juvenile grade.

Of course it is not suggested that only such as have had advanced training (whether in college or out makes no difference) be admitted to a meteorological service. Those who are mentally capable of acquiring such training seldom are temperamentally adapted to the necessary task of hewing wood and drawing water; and, besides, whatever their temperament, the training in question would but make them fretful, discontented and inefficient in mentally cramped quarters from which no speedy relief was in sight. But on the other hand knowledge is power, and the adequately trained man, however and wherever he got his training, can make many a position intellectually respectable that to the untrained affords only a daily grind of routine tasks. Furthermore, and this is especially to the point, the chief advances in any subject come almost wholly from the better trained in that subject, just as almost every suggestion during the World War, worthy of trial and adoption, came from a small number of trained scientists, and hardly any from all the other patriots—earnest and anxious, but impotent for lack of knowledge of the principles involved.

In order, then, that the science of the atmosphere may become truly worthy of a respectable place at college, a place that would enable meteorological services, aerodromes, airways and the whole growing field of aeronautics, and other interests besides, to draw from the upper levels of college and not from the lower—or lower still—it is imperative that we somehow make easily accessible meteorology's vast mathematical and physical assets. In great measure they are frozen, terribly frozen, but they must be made liquid. It can be done and must be done. This is meteorology's greatest opportunity and most urgent need.

W. J. HUMPHREYS

U. S. WEATHER BUREAU,
WASHINGTON, D. C.

HIGH FREQUENCY RADIATION OF THE X-RAY TYPE[1]

IN my address last year, I referred to recent advances in the production of very high voltages for technical purposes, and the application of these voltages to highly exhausted tubes in order to obtain a copious supply of high-speed electrons and atoms and high-frequency radiation. It is of interest to note how rapidly in recent years our ideas have widened as to the possibilities of production of very high-frequency radiation of the X-ray type, both by artificial and natural processes.

In my address this afternoon, I shall briefly consider the present state of our experimental knowledge on this subject, and the various directions of attack by which we may hope to get further information. On the quantum theory, the energy associated with a quantum of radiation of frequency ν is given by $h\nu$, where h is the well-known constant of Planck. When swift electrons impinge on matter, radiation of an X-ray type is generated over a wide range of frequencies, and it has been verified experimentally that the maximum frequency of the radiation obtainable in this way is limited by the relation $E = h\nu$, where E is the energy of motion of the electron, a result in accordance with energy considerations.

For purposes of discussion, it is very convenient to express the energy of a quantum not in ergs but in terms of a potential difference in volts, through which an electron must fall to acquire an equal energy. Expressed in this way, the energy of a quantum of green light corresponds to 2 electron-volts or 2 volts

[1] From the address of the president of the Royal Society, London, given at the anniversary meeting, November 30, 1928, and printed in the *Proceedings* of the society.

for brevity. Before the advent of X-rays, the highest frequencies examined were confined to the ultra-violet part of the light spectrum, corresponding to less than 10 volts. Following the discovery of X-rays and the application of methods for determining their frequency, we have been enabled to study radiations over a wide range of individual energy, varying from a few hundred volts to 300,000 volts or more. By the use of special gratings and other methods, the gap in frequency between ordinary ultra-violet light and soft X-rays has been bridged in the last few years. There appears to be no limit to the maximum frequency that can be obtained by the bombardment of matter with electrons, except the practical difficulty of obtaining streams of the requisite high-velocity electrons. In some recent experiments in the Institute of Technology, Pasadena, about 1 million volts has been successfully applied for a short time to a suitably designed X-ray tube. It is stated that the X-rays obtained were of such intensity and penetrating power that they could easily be observed by the luminosity on a phosphorescent screen 100 feet away.

So far our experiments in this direction have been limited to about 1 million volts, and we have not yet been able to produce X-rays in the laboratory of penetrating power equal to that shown by the gamma-rays spontaneously emitted by radioactive bodies. The highest frequency observed in their transformations corresponds to between 3 and 4 million volts. Some recent experiments indicate that the gamma-rays which accompany the weak radioactivity of potassium are of still greater penetrating power than the rays from radium, but no definite estimate of the maximum frequency has so far been made.

There is, in addition, another general method of estimating the frequency of radiation that may arise in certain fundamental atomic processes of a simple type. According to modern views energy and mass are closely connected, and the relation between the energy E resident in a mass m is given by the well-known equation of Einstein $E = mc^2$, where c is the velocity of light. According to this view, if any system decreases in mass by internal rearrangement, the total energy lost in the process is given by the product of the change of mass multiplied by c^2. If this energy is emitted in the form of a radiation of one definite frequency ν, then $h\nu = c^2 dm$, where dm is the accompanying change of mass of the system. On account of the very small change of mass even for a large emission of energy, it is difficult to give a direct experimental proof of this relation, but there seems to be little doubt of its general validity. Even for the radioactive bodies, which in their successive transformations spontaneously emit a very large amount of energy per atom, in the form of alpha-, beta- and gamma-rays, the effect to be expected is small and difficult to measure. The atom of uranium, of mass about 238, after successive transformations involving the loss of eight alpha-particles changes into an isotope of lead, of mass about 206. It is to be anticipated, that, if the methods of positive ray analysis could be applied to these elements, the difference between the atomic masses of uranium and the resulting lead would include not only the mass of 8 helium nuclei in the free state, but also about $0 \cdot 05$ unit of atomic mass corresponding to the total emission of energy of about 46 million electron-volts per disintegrating atom of uranium. This difference—about 1 in 4,000—should be just detectable by the methods employed by Aston in his study of isotopes. Similarly the change in mass in each transformation can be deduced if the energy released during the process is known experimentally.

We shall now consider the application of these ideas to certain nuclear processes. It is now generally accepted that the nuclei of all the elements are composed of protons (hydrogen nuclei) and electrons. While it is, of course, difficult to give a definite proof of this hypothesis, we know that it is strongly supported by the work of Aston on the atomic masses of the isotopes of the elements, and by the experiments on the liberation of protons from certain light elements when bombarded by swift alpha-particles. It is generally supposed that the helium nucleus is composed of a close combination of four protons and two electrons. The mass of the helium atom is $4 \cdot 00216$ ($O = 16$), while the mass of four hydrogen atoms in the free state is $4 \times 1 \cdot 0078$. There is in consequence a loss of mass of $0 \cdot 029$ units in the formation of the helium atom. This indicates a loss of energy of 27 million electron-volts in the process of building a helium nucleus from free protons and electrons. If it be possible to imagine that in some way this energy is emitted catastrophically, in a single quantum of radiation, the energy of the quantum would correspond to 27 million volts. The energy emitted per atom is thus very large, and it has been suggested by Eddington and others that the formation of helium from hydrogen nuclei and electrons may be one of the sources of the energy radiated from the stars.

In a similar way the total energy emitted during the formation of any atom of known mass from free protons and electrons may be estimated. Since the proton in a free state has a mass $1 \cdot 0073$, and a mass about $1 \cdot 000$ in the average nuclear combination, the energy released per proton is about 7 million volts. For example the atomic weight of the most abundant isotope of mercury (atomic number 80) is $200 \cdot 016$,

and this presumably contains 200 protons, of mass nearly unity, and the 120 electrons. Disregarding the small mass due to the electrons, we may conclude that the total energy emitted during the formation of a mercury atom from free protons and electrons is about 1,400 million electron-volts.

When we consider the extreme complication of such a heavy nucleus and the number of its component parts, it is difficult to believe that this emission of energy can take place in one single catastrophic act. It is so much more likely that the energy is emitted in a step by step process during the organization of the nucleus. Except for light atoms, where the nuclear structure is simple, it is to be expected that the radiation of energy from all complex nuclei would occur in successive stages.

On the other hand, there is one possibility to consider, which was first put forward by Jeans to account for the long lives of the hot stars. He supposes that even the protons and electrons are not indestructible, but may under unknown conditions be transformed into radiation. The total internal energy of the electron is about 500,000 volts, but of the proton 1,840 times greater, or about 940 million volts. If we suppose the proton and electron to disappear together in the form of radiation, there must be an enormous liberation of energy. If this energy be emitted in a single quantum, we should expect to obtain a gamma-radiation corresponding to about 940 million volts. Such a hypothesis is admittedly of a very speculative nature and may be very difficult of direct proof or disproof.

Apart from the radioactive bodies, we have no definite experimental evidence of the emission of penetrating radiations, either in the formation of atoms or destruction of protons, and it may be that the processes considered do not take place under the conditions of our experiments on the earth. On the other hand, the long life of the hot stars indicated by general astronomical evidence does seem to demand some such process or processes, in which the liberation of energy is enormous compared with the mass involved.

It is thus of very great interest to examine whether any direct experimental evidence can be obtained of the existence of such extraordinarily energetic gamma-rays. This interest is heightened by the experiments in recent years which have shown the existence of an extremely penetrating type of radiation, sometimes called the "cosmic" rays, in our atmosphere—a radiation much more penetrating than the gamma-rays from the radioactive bodies. This radiation has been detected and measured by the small ionization produced in a closed electroscope. The initial observations were made by Hess and by Kolhörster, and we owe much to the admirable experiments of Millikan and Cameron, who have carefully examined the absorption of this radiation by the water of mountain lakes, which are practically devoid of ordinary radioactive matter.

It is clear from these experiments that the radiation is complex in character, and that there are present radiations which are able to pass through 17 meters of water for a reduction of intensity to one half value. It is natural to suppose that this radiation is of a gamma-ray type, but it should be borne in mind that the effects so far observed would be equally explicable if the radiations consisted not of high-frequency gamma-rays, but of high-energy electrons entering our atmosphere.

Assuming, however, that the radiation is of the gamma-ray type, it is necessary to consider the factors that determine the absorption of such a radiation by matter. During the past 20 years, the problem of the nature of the absorption of X-rays and gamma-rays by matter has been the subject of detailed investigations, and there is now a general consensus of opinion on the main features of the processes involved. In the case of the heavier elements, the absorption of ordinary X-rays is mainly due to the interaction between the radiation and the electrons in the atom, whereby the energy of the quantum of radiation is transferred to the electron. This is generally known as the "photoelectric" effect. In addition there is a relatively small loss of energy due to the scattering of the incident radiation by the electrons; but in general, except for very high-frequency X-rays and light elements, the absorption due to the photoelectric effect predominates. The case is quite different when we deal with penetrating gamma-rays, where the loss of energy due to the process of scattering becomes relatively much more important, and for radiation of energy of the order of 100 million volts almost completely governs the absorption.

The main features of this scattering, known as the Compton effect, are now well understood. There is an occasional interaction between the quantum of radiation and the electron in an atom, whereby the radiation is scattered and the electron set in motion. The scattered radiation is always of lower frequency than the incident radiation, the difference depending on the angle of scattering. In this type of encounter between radiation and an electron, both momentum and energy are conserved, and consequently the energy given to the electron depends on the nature of the encounter, and thus on the angle of scattering of the radiation. The essential correctness of this theory has been verified by several distinct methods.

When a pure radiation of definite frequency is passed through matter, there always remains some transmitted radiation which has not been transformed,

but mixed with it are degraded radiations of much lower frequency and swift electrons set in motion by the process of scattering. The ionization observed in a closed vessel is probably mainly due to the electrons liberated by scattering in the medium and the walls of the containing vessel.

Assuming that the laws of the Compton process of scattering are valid for high-frequency radiation, there still remains the difficulty of estimating the probability of such scattering encounters, for on this probability depends the actual magnitude of the absorption coefficient. Different methods of calculating this probability have been given by A. H. Compton, Dirac, and recently by Klein and Nishina. The theory of Compton is based mainly on classical analogies, and that of Dirac on the earlier quantum mechanics. Recently the problem has been attacked again by Klein and Nishina (*Nature,* Sept. 15, 1928), using the later relativistic form of wave-mechanics formulated by Dirac. The calculated absorption coefficients for high-frequency radiations differ materially from one another on these three theories, and in particular the theory of Klein and Nishina gives a greater absorption coefficient for a given high-frequency radiation. For radiations of individual energy more than 100 million volts, the coefficient is about five times greater than that given by the formula of Dirac.

Unfortunately the experimental evidence available from a study of the absorption of the most penetrating gamma-rays from radioactive bodies is not complete enough to give a definite test of the validity of these theories. However, Mr. Gray, of the Cavendish Laboratory, who has made a careful examination of existing data on the absorption of gamma-rays, informs me that the evidence as a whole is more in accord with the theory of Klein and Nishina than with the earlier theories of Compton and Dirac. It is evident, however, that in view of the importance of the question, a careful determination is required of the absorption and scattering of gamma-rays, of as definite frequency as possible, in order to distinguish between the various theories.

It is of interest to note that the absorption coefficient of the most penetrating type of radiation, deduced by Millikan and Cameron from their experiments, is in excellent accord with that to be expected on the Klein-Nishina theory for a quantum of energy 940 million volts—the energy demanded for the transformation of the internal energy of the proton into radiation. Although this agreement is suggestive, our theories of absorption are at present too uncertain to place much weight upon it. Even if subsequent experiment should prove the correctness of an absorption formula within a certain range of frequency corresponding to the gamma-rays there would still be the need of extrapolating the formula over a very wide range, say from quantum energies of 3 million volts to 1,000 million volts, to include the ultra-penetrating rays observed in our atmosphere.

In addition there are a number of new factors which may have to be taken into consideration when we are dealing with the passage of very high-frequency radiation through matter. In the ordinary theories, the scattering of the radiation is supposed to be confined to the extra-nuclear electrons, but if we are dealing with a quantum of energy corresponding to the order of 100 million volts, it is not unlikely that the nuclear electrons may be effective in scattering as well as the outer electrons. Such an effect is to be expected if the energy of the quantum is large compared with the energy required to release an electron from the nucleus. In addition there is always the possibility, and even the probability, that such energetic radiations or the swift electrons liberated by them may be able occasionally to disintegrate the nucleus of the atom in their path.

For all these reasons, it is evident that much more information is required before we can draw any but tentative conclusions as to the nature of the penetrating radiations in our atmosphere. So far, experiments have been mainly confined to measuring the ionization produced in a sealed electroscope. Further experiments are required, which will give us definite indication of the energy of the swift electrons present in the atmosphere, for this will give us valuable information on the maximum frequency of the radiation present, quite independently of the exact accuracy of our theories of absorption.

Continued observation made in a Wilson expansion chamber should throw much light on the nature of the particles which produce the ionization in a closed vessel, and with the addition of a magnetic field of sufficient intensity the curvature of the tracks of beta-rays should enable us to determine their individual energy. Experiments of an analogous kind have already been made with an expansion chamber by Skobelzyn, in order to determine the relative intensities of the main gamma-rays emitted by radium C. In the course of these experiments he has observed on several occasions the trails of very energetic beta-particles, probably arising from the ultra-penetrating radiation in our atmosphere.

During the present year Professor Hans Geiger has developed a modified form of beta-ray counter, which records each beta-particle entering a vessel of considerable volume in any direction. This new method is so delicate that it may prove very useful in counting and even recording the number of beta-particles pro-

duced by the penetrating radiation. While it is to be hoped that in the years to come we may have available for study in our laboratories swifter beta-rays and higher-frequency radiation than we have to-day, we can hardly hope in the near future to produce artificially radiations, atoms and electrons which have an individual energy of the order of 100 million to 1,000 million volts, such as are present in our atmosphere.

It is thus of great interest and importance to use every promising method of attack to throw light on the nature and origin of these penetrating radiations and the effects arising in their transmission through matter. The magnitude of the effects to be observed is small and not easy to measure with accuracy; but with the ever-increasing delicacy of methods of attack we may hope to gain much further information. The study of these extraordinarily penetrating radiations is not only of great interest in itself, but also for its promise of throwing new light on fundamental processes in our universe connected with the building up and destruction of atoms. It may take many years of faithful experiment before the evidence is sufficient to test the correctness of the numerous interesting speculations that have been advanced to account for the origin and nature of these radiations.

ERNEST RUTHERFORD

SCIENTIFIC EVENTS

THE NATIONAL RESEARCH COUNCIL OF ITALY

THE National Research Council of Italy held its inaugural meeting on February 2 in the presence of Signor Mussolini and of the president, Senator Marconi. Modern scientific research, said Signor Mussolini, according to the London *Times*, required an adequate organization and vast means. It was the lack of these in the past that had led to the present decadence of research and to the paucity of research workers in Italy. To remedy this situation individual research workers needed to be assured that they could "live by science and for science."

The National Research Council, added Signor Mussolini, must keep in living contact with the industrialists, agriculturists, the business men and the administrative authorities, and in particular with the different confederations of employers and workers, since scientific research ultimately resulted in improvement and increase of production. The Seamen's and Airmen's Confederation had already offered 100,000 lire to the council for research into ways of life-saving at sea and the better utilization of fuel by ocean craft.

The inadequacy of individual and unorganized research was also laid stress upon by Senator Marconi, who referred to the need of coordination and discipline among research workers. It was important, he said, that a discovery made or piece of research work begun in Italy should mature and develop so far as possible in Italy. At the same time, means should be found for a rapid development and application in Italy of inventions made abroad. Twelve national research committees had already been formed in Italy in the fields, respectively, of agriculture, astronomy, biology, medicine, chemistry, physics, geodetics, geography, geology, engineering, mathematics and wireless telegraphy. Research in agriculture was for Italy of capital importance, as also was every application of science destined to make Italy less dependent on foreign imports. In conclusion, Senator Marconi recalled for the inspiration of Italian researchers the motto of Galileo, the greatest of their scientists: "Try and try again."

A BELGIAN ROYAL COLONIAL INSTITUTE

THE *Journal* of the American Medical Association reports that a royal decree has established a Belgian Royal Colonial Institute. Similar institutes exist in all large countries possessing colonies. Particularly the royal colonial institution of Amsterdam has awakened appreciation of the important services that a central colonial institute can render when it carries on scientific researches and serves as a clearing house of practical information in connection with the economic problems that affect the colonies. Many organizations in Belgium are engaged in the study of colonial problems, such as native politics and jurisprudence; agricultural and industrial colonization; transportation problems and equipment for the colonies. Now their activities will be concentrated and a unity of direction will be established. It is desirable that interest in the colonies be developed in the universities and in other institutions of higher learning. The young people of the country should become familiar with colonial needs and colonial services, for that would aid later in procuring physicians, civil engineers, magistrates and administrators whose knowledge and experience would contribute to the efficient administration of the colonies and to the prosperity of colonial enterprise.

The Institut Royal Colonial Belge is divided into three sections. The first section, of moral and political sciences, deals particularly with questions pertaining to history, native politics, colonial legislation, ethnology, languages, literature and missions. The second section, of natural and medical sciences, deals with questions of physical and commercial geography, geology, chemistry, botany, zoology and entomology, hygiene and medicine, agriculture and

animal husbandry. The third section, of technical sciences, handles problems pertaining to transportation, communications, civil engineering, colonial equipment, implements and mine exploitation.

PLANT EXPLORATION IN MADAGASCAR

DR. CHARLES F. SWINGLE, botanist of the Bureau of Plant Industry, recently returned to Washington from a plant-exploration expedition to Madagascar, bringing back a mass of plant material which the bureau hopes will prove to contain a number of useful and valuable additions to the ornamental and economic plant life of the United States. Dr. Swingle was accompanied on the expedition by Professor Henri Humbert, professor of botany in the University of Algiers, North Africa, an authority on the plant life of Madagascar. As far as there is record, Dr. Swingle is the first American botanist to visit Madagascar, an island, nearly a thousand miles long, a possession of France, lying in the Tropic and Temperate Zones of the Southern Hemisphere in the Indian Ocean off the southeast coast of Africa.

The material brought back by Dr. Swingle, consisting mainly of live plants and seeds, will be tested for adaptation in the United States, but of course it may be many years before the value of it all is known.

Numerous ornamental plants—shrubs, vines and trees—some of which are unidentified, were in the collection. Of these, 12 species of Kalanchoe seem to be the most promising, especially in the southern states. Other promising ornamentals collected are a number of specimens of elephant's foot, several aloes and a striking and rare hibiscus-like plant.

In the collection are 23 lots of plants which seem to have some value as potential sources of rubber. Ten of these are now being commercially exploited for rubber in Madagascar. Some of them have been introduced previously into the United States and are now being tested in the department's experiment garden in southern Florida, but undoubtedly several are entirely new to the United States. The southern part of Madagascar, which lies just outside the Tropics in the South Temperate Zone, is like parts of our own southwest in many respects and the bureau hopes that some of these new rubber plants may be adapted there.

Apparently the real prize of the expedition consists of live specimens of *Euphorbia Intisy,* an almost extinct species of rubber-yielding plant. Twenty-five years ago the rubber from this plant was highly prized in France for making automobile tires. But the high value of this rubber spelled the doom of the species as a commercial one, at least for the time, for the natives collected the rubber so ruthlessly that even most botanists acquainted with Madagascar feared the species had become entirely extinct. The Humbert-Swingle expedition found some of these plants growing in an arid region, subjected yearly to six months without rain and sometimes to drought lasting as many years. This plant, which is almost leafless, is able to withstand these extremely arid conditions by having a water-storing root system of unique type.

Before leaving Madagascar with the collection, much of which was obtained near Fort Dauphin on the southeast coast, Dr. Swingle left a duplicate set of the living plants at Tananarivo, the capital, in the east-central interior, as a sort of "nest egg" to provide replacements in case of losses or injury to the collection during its long journey to the United States. Another duplicate set was sent to the University of Algiers, which cooperated in the expedition.

Dr. Swingle's trip was made possible through the cooperation of the Bureau of Plant Industry with the Arnold Arboretum, of Boston, with the University of Algiers, and by the friendly interest and numerous courtesies of the French and Madagascar governments.

A PROPOSED NATIONAL MONUMENT IN THE BAD LANDS OF SOUTH DAKOTA

THIS proposed national monument, which embraces a great part of the most scenic and interesting section of the South Dakota Bad Lands, is to be established by presidential proclamation, when certain requirements provided in a bill (S. 4385), upon which the House Committee on Public Lands has voted a favorable report after amending the measure as it came from the senate, have been met.

The total area proposed to be set aside in the substitute measure comprises approximately 50,760 acres (a reduction of 18,360 acres from the area proposed in the original bill), of which approximately 3,760 acres are privately owned.

The boundaries of the monument are fully set out in the bill, in which provision is made for its administration, protection and promotion under the National Park Service act.

The following are the conditions which must be met before the proposed act shall become effective:

1. A quantum of the privately owned lands within the proposed area, satisfactory to the Secretary of the Interior, must be acquired and transferred to the United States for monument purposes without cost to the government; and

2. Construction by the State of South Dakota, in a manner satisfactory to the Secretary of the Interior, of approximately 30 miles of highway, same to extend from

the town of Interior in a northwesterly direction to and over Big Foot Pass and through the region known as The Pinnacles, thence in a westerly direction to Sage Creek.

The bill also provides that only recognized scientific and educational institutions, upon permit from the Secretary of the Interior, shall be allowed to conduct expeditions within the monument area for the advancement of geological and zoological science.

The topography of the South Dakota Bad Lands is so unique, varied and interesting, and the fame of the region as a large field for scientific exploration of the geological past is so extensive, the committee feels that its scenic and educational features should be preserved for the use and enjoyment of the people.

The White River Bad Lands consist of the most important bad-land area of the world, several of the most interesting parts of which are included in the proposed bill. They lie generally in southwestern South Dakota, the most scenic part being in Pennington and Jackson Counties, and cover an area of about 1,000 square miles. A prominent arm, known as Pine Ridge, extends through northwestern Nebraska into eastern Wyoming. From Pennington County the Bad Lands extend northward for miles and miles in the form of lesser ranges, isolated mounds, buttes and offshoots.

The chief topographical features of the area embraced in the bill are The Pinnacles and the Great Wall. Viewing the former from the tableland, the spectator beholds a vast area of rutted ravines, high ridges, hills and cliffs of grayish white soil with varied stratas of coloring, extending as far as the eye can reach. The contour is so rugged that considerable of this region has never been surveyed. The fantastic outlines of these formations are constantly being changed by erosion.

In this region abound vast beds of fossil remains. Geologic formations, peculiar to this locality, appear in great variety. The whole area is a vast storehouse of the biological past, and for three quarters of a century it has been the scene of operations for scientific expeditions from all parts of the world. Specimens of these fossil remains repose in the world's principal museums.

THE WORLD'S ENGINEERING CONGRESS

THIRTY-TWO New York engineers and scientific men, with their families, will sail on the special ship reserved for the American delegation to the forthcoming World's Engineering Congress at Tokio, according to an announcement made by Dr. Elmer A. Sperry, chairman of the American committee. The entire New York party, which is scheduled to sail from San Francisco on October 11, will number sixty-four, and it is expected that this group will be augmented by further requests for passage on the ship.

The New York engineers, most of whom will be accompanied by their families, include: Edward Dean Adams, C. M. Keys, L. A. Osborne, Allen Hazen, J. V. W. Reynders, Robert Ridgway, Dr. Frank B. Jewett, George W. Fuller, Farley Osgood, George W. Gibbs, Dr. H. Foster Bain, Calvin W. Rice, Maurice Holland, E. De Golyer, F. L. Hutchinson, R. H. Colvin, H. de Berkeley Parsons, B. E. Eldred, Lawrence Addicks, Alfred D. Flinn, H. W. Harding, Daniel T. Turner, George T. Orrok, Dr. D. S. Jacobus, Ernest Hartford, William A. McDonald, Bert Emery, Colonel A. S. Dwight, Professor James W. Roe, Lacey H. Morrison, Magnus W. Alexander and Ernest Behrend.

The party is to arrive at Tokio via Honolulu on October 28, the day before the opening of the congress. The itinerary of many of the members of the New York delegation includes a world cruise following the meeting, although it is expected that many will take advantage of the invitation of officials of the congress to visit Japan's great industrial centers and to tour the empire's recreation and scenic centers.

PRESIDENT HOOVER ON EDUCATION AND PUBLIC HEALTH

IN his inaugural address on March 4 President Hoover said:

Although education is primarily a responsibility of the states and local communities, and rightly so, yet the nation as a whole is vitally concerned in its development everywhere to the highest standards and to complete universality.

Self-government can succeed only through an instructed electorate. Our objective is not simply to overcome illiteracy. The nation has marched far beyond that. The more complex the problems of the nation become, the greater is the need for more and more advanced instruction. Moreover, as our numbers increase and as our life expands with science and invention, we must discover more and more leaders for every walk of life.

We can not hope to succeed in directing this increasingly complex civilization unless we can draw all the talent of leadership from the whole people. One civilization after another has been wrecked upon the attempt to secure sufficient leadership from a single group or class.

If we would prevent the growth of class distinctions and would constantly refresh our leadership with the ideals of our people, we must draw constantly from the general mass. The full opportunity for every boy or girl to rise through the selective processes of education can alone secure to us this leadership.

In public health the discoveries of science have opened a new era. Many sections of our country and many groups of our citizens suffer from diseases the eradication

of which are mere matters of administration and moderate expenditure.

Public health service should be as fully organized and as universally incorporated into our governmental system as is public education. The returns are a thousandfold in economic benefits and infinitely more in reduction of suffering and promotion of human happiness.

SCIENTIFIC NOTES AND NEWS

THE degree of doctor of science has been conferred by the University of Oxford on Dr. Oswald Veblen, professor of mathematics at Princeton University, now lecturing at Oxford.

THE Nichols medal of the New York section of the American Chemical Society, awarded to Dr. William Lloyd Evans in recognition of his achievements in studying the sugar molecule, was presented to him at a meeting of the section on March 1. Dr. R. R. Renshaw presided. Dr. Evans read a paper on the mechanism of carbohydrate oxidation.

DR. JOHN J. ABEL, of the Johns Hopkins University, Dr. John H. Finley, of the New York *Times*, the Honorable John W. Davis, and Dr. Charles H. Herty, of the Chemical Foundation, will be the speakers on the occasion of the presentation by the American Institute of Chemists to Mr. and Mrs. Francis P. Garvan of the medal for outstanding service to the science and profession of chemistry in America. The presentation will be made on May 4.

DR. J. A. V. BUTLER, lecturer in physical chemistry in the University of Edinburgh, has been awarded the Meldola medal of the Institute of Chemistry for his work on the modern theory of conducting solutions.

THE Council of the British Institution of Electrical Engineers has made the eighth award of the Faraday medal to Signor Guido Semenza, of Milan.

THE first Colwyn gold medal has been awarded by the council of the Institution of the Rubber Industry of Great Britain to G. Stafford Whitby, professor of organic chemistry at McGill University. The medal was instituted by Lord Colwyn in 1928 to be awarded for conspicuous services of a scientific or technical character having an important bearing on the improvement or development of rubber manufacture or production. The medal is to be presented to Professor Whitby in the spring, when he expects to visit England.

THE New Year's Honors List of Great Britain includes a peerage for Sir Berkeley Moynihan, president of the Royal College of Surgeons. Dr. John A. Fleming, professor emeritus of electrical engineering in the University of London, has received knighthood.

NOTES in SCIENCE have stated that the Edison medal of the American Institute of Electrical Engineers had been awarded to Dr. Frank B. Jewett and also to Dr. W. D. Coolidge. This medal was presented this year to Dr. Jewett and last year to Dr. Coolidge.

AN exchange has been arranged between Princeton University and the Lowell Observatory at Flagstaff, Arizona, according to which Dr. Carl Lampland will work at Princeton while Dr. Raymond S. Dugan will work at Flagstaff.

DR. L. L. WOODRUFF, professor of protozoology in Yale University, is in residence at Washington as chairman of the Division of Biology and Agriculture of the National Research Council.

DR. H. W. TYLER, head of the department of mathematics at the Massachusetts Institute of Technology, is on leave of absence in Washington, D. C., in order to establish there a permanent office of the American Association of University Professors, of which he has acted as secretary for many years. Professor Tyler was reelected secretary at the recent New York meeting.

DR. SAM LENHER, a former fellow of the International Education Board and recently National Research Fellow in Chemistry, has joined the staff of the experimental station of E. I. du Pont de Nemours and Company, Wilmington, Del.

DR. GEORGE F. REDDISH, formerly senior bacteriologist in the food, drug and insecticide administration of the U. S. Department of Agriculture, is now with the Lambert Pharmacal Company, St. Louis, as chief bacteriologist. Dr. Reddish assumed his new work on February 1.

DR. W. A. MORGAN, formerly state chemist with the Georgia Department of Agriculture, has accepted a position with Lazote, Inc., and is at present at the Experimental Station, Wilmington, Delaware.

AT a special meeting of the board of trustees of the American Museum of Natural History on February 21, Mr. George T. Bowdoin, of the Bankers Trust Company, was elected to fill the vacancy on the executive committee created by the recent death of Ogden L. Mills.

HERBERT P. WHITLOCK, curator of minerals and gems at the American Museum of Natural History, New York, has been appointed honorary curator of mineralogy at the Wadsworth Atheneum and Morgan Memorial, Hartford, Conn.

HAROLD J. COOK, of Agate, Nebraska, has been made active curator of the department of paleontology

of the Colorado Museum of Natural History at Denver, having served in the past as honorary curator. Robert J. Niedrach is now head of the department of ornithology and will proceed with the preparation of the specimens secured by the last two South American expeditions, which are to be installed in the new South American wing.

DR. B. A. ETCHEVERRY, professor of irrigation at the University of California, has leave of absence from March 26 to June 30, to study irrigation, reclamation and flood control in Italy, France and Spain.

DR. GEORGE N. WOLCOTT, who for the past year has been entomologist for the Estaçion Experimental Agricola of Lima, Peru, during the absence of Dr. C. H. T. Townsend in Europe, where he has been studying the types of Muscoid Diptera, is returning early in April.

KENNETH P. EMORY, ethnologist for the Tuamotuan Archipelago at the Bishop Museum, Honolulu, Hawaii, has sailed to continue the investigation of Polynesian island groups inaugurated by the museum in 1920.

DR. WILLIAM J. SCHIEFFELIN was reelected head of the American Mission to Lepers at the recent annual meeting. It was decided to send Dr. Lee S. Huizenga on a year's tour of countries where leprosy prevails to attend conferences, to stress the need for action against leprosy and to initiate programs of public health education. He will inform local physicians, chiefly in Asia, of the modern treatment of leprosy and will urge the establishment of out-patient clinics.

FRANK CORTESE, formerly research associate at the Massachusetts Institute of Technology, is now National Research Fellow at the University of Munich, Germany, investigating the alkaloids of ergot with Professor Heinrich Wieland.

DR. F. STRUECK, of the University of Würzburg, is visiting the United States in order to make a study of work in nutrition.

DR. ERNEST W. GOODPASTURE, professor of pathology at the Vanderbilt University School of Medicine, delivered one of the De Lamar lectures in hygiene at the Johns Hopkins School of Hygiene and Public Health on February 26 on "Herpetic Infection, with Especial Reference to Involvement of the Nervous System."

DR. ROY GRAHAM HOSKINS, director of The Memorial Foundation for Neuro-endocrine Research at the Harvard Medical School, is giving the third series of lectures under the Harrington Foundation at the University of Buffalo as follows: April 4, "Interrelations of the Endocrines"; April 5, "Practical Endocrine Therapy."

DR. C. G. ABBOT, secretary of the Smithsonian Institution, gave an address on February 18 on the life and work of Spencer Fullerton Baird, the second secretary of the institution, at Dickinson College, Carlisle, Pennsylvania.

PROFESSOR ALEXANDER SILVERMAN, of the University of Pittsburgh, delivered a public lecture on the occasion of the annual convention of the American Ceramic Society in Chicago on "Modern Glass Manufacture in Europe and Glass Collections in European Museums," illustrated by motion pictures taken during his three months' tour of Europe last summer.

"PREHISTORIC Man, His Industries, Inventions, Beliefs, Artistic Production" was the subject of a recent lecture given by Dr. Henry M. Ami, director of the Canadian School of Prehistory, before the Sigma Xi chapter of McGill University. The lecture was illustrated with views taken by the lecturer.

THE Third National Symposium on General Organic Chemistry will be held at Princeton University late in December, 1929. The executive committee is as follows: E. C. Franklin, *chairman,* Stanford University; Frank C. Whitmore, *secretary,* Northwestern University; W. L. Evans, Ohio State University; F. B. Dains, University of Kansas, and J. B. Conant, Harvard University.

UNDER the auspices of the Bussey Institution, Harvard University, Professor Nikolai A. Borodin, formerly dean of the Department of Fish Culture and Fisheries, Petrograd Agricultural College, is giving a series of lectures on "Biology as Applied to Fisheries and Fish Culture."

PROFESSOR G. H. HARDY, of the University of Oxford, who has been lecturing at Princeton University during the first semester of the present academic year on "Chapters in the Theory of Functions," lectured at the Ohio State University on January 18 on the "Theory of Primes," and at the University of Chicago on January 21 on the "Analytical Theory of Numbers."

SIR ERNEST RUTHERFORD opened a discussion at the Royal Society on February 7 on "The Structure of Atomic Nuclei." Dr. F. W. Aston, Dr. J. Chadwick, Dr. C. D. Ellis, R. H. Fowler and Professor O. W. Richardson took part in the discussion.

THE suicide of Professor Clemens Pirquet, director of the Children's Clinic in Vienna, together with his wife, is announced in the daily press.

A CONFERENCE of research workers and others interested in investigation and control of root rot, caused by the fungus *Phymatotrichum omnivorum*, was held at the Texas Agricultural Experiment Station on January 14 and 15. The results of investigations with this disease in the Texas Experiment Station, the U. S. Department of Agriculture Bureau of Plant Industry and Bureau of Chemistry and Soils and the Arizona Experiment Station were presented by workers from these organizations. A more detailed account of the conference will be published in *Phytopathology*.

THE Pasteur Society of central California met at the Hotel Whitcomb in San Francisco on February 27, with one hundred and ten members and guests present. The general subject was tuberculin. Dr. J. Traum, University of California College of Agriculture, division of veterinary science, Berkeley, spoke on "Tuberculin, with Special Reference to its Use in Animals"; Dr. Zera A. Bolin, University of California Medical School, Department of Pathology, San Francisco, discussed the pathological aspects; Dr. Frederick Eberson, University of California Medical School and the George Williams Hooper Foundation for Medical Research, San Francisco, spoke on "The Clinical Aspects of Immunity in Tuberculosis"; Dr. Robert A. Peers, medical director of the Colfax School for the Tuberculous, California, discussed the practical use of tuberculin in human tuberculosis. Thirty-six new members were elected to the society. Officers elected for the calendar year are: *President,* Captain V. H. Cornell, M. C., U. S. A., Letterman General Hospital, San Francisco; *vice-president,* Dr. C. S. Mudge, division of dairy industry, University of California College of Agriculture, Davis; *secretary-treasurer,* Dr. M. S. Marshall, George Williams Hooper Foundation for Medical Research; *councillors,* Miss Ida May Stevens, assistant epidemiologist, State Department of Public Health, San Francisco, and Dr. E. C. Dickson, professor of epidemiology, Stanford Medical School.

WE learn from *Nature* that at the University of Cambridge a syndicate consisting of the vice-chancellor; Sir J. J. Thomson, master of Trinity; Professor Seward, master of Downing College; Dr. Willis, Dr. A. W. Hill, Dr. H. Hamshaw Thomas, Professor A. G. Tansley, Sherardian professor of botany in the University of Oxford; A. Amos, R. A. Hayes, and F. L. Engledow has been appointed to consider the organization and finance of the Botanic Garden and the relations between the garden and the department of botany and other scientific departments, and to report to the university by the end of the ensuing term.

THE *Journal* of the American Medical Association reports that, through the generosity of Mrs. Grace V. Harris, an endowment has been furnished for completely equipped laboratories for research in metabolic diseases at Carmel, California, and for the housing of about twenty-five patients. The building is now under construction. The initial expenditure will be about $200,000, with ample provision for continued maintenance funds for research. The aim will be to increase the knowledge of metabolic diseases and to provide facilities for diagnosis and treatment. The staff at first will comprise Dr. Rudolph A. Kocher (formerly of the Hooper Foundation), University of California, as medical director, and Julian R. Blackman (now at Stanford University School of Medicine), in charge of the roentgen-ray department; the two other appointments are yet to be made.

THE University of California Museum of Vertebrate Zoology has established scientific connections with the United States of Soviet Russia, and received its first shipment of specimens from Dr. B. Vinagradov, of the Zoological Museum of the Academy of Sciences, Leningrad. The shipment was received in exchange for material sent to Leningrad by the university, under a plan proposed by Dr. E. Raymond Hall, curator of mammals at the University Museum. He was desirous of obtaining a number of specimens from Russia, and offered to send 200 American specimens in exchange for those he wanted.

PREPARATIONS are on the way for the fourth season of excavations at Combe Capelle in the Dordogne District of France, by the Canadian School of Prehistory in France. The director, Dr. H. M. Ami, in charge at Combe Capelle, in the Mousterian and other deposits of the Couze Valley, will be pleased to furnish such information as may be deemed necessary regarding prospective students in this field of prehistoric research. The results of 1929 work are being classified and distributed to various university museums of Canada.

BIRD sanctuaries in every state and in Alaska will be established under the provisions of the Norbeck migratory bird bill, which has been signed by President Coolidge. Not only will migratory and game birds be protected, but all wild life is to live unmolested in the sanctuaries. The program for establishment of the refuges is expected to be completed within ten years.

ANOTHER attempt to climb Mount Everest in the Himalayas will be made this summer by a party of Dutch alpinists and scientific men, aided by Swiss and Indian guides. The Swiss guide Franz Lochmatter, who climbed the Rockies and Andes with

leading American climbers during the past few years, has left Zermatt for Amsterdam to join as chief guide to the Dutch expedition, which is leaving shortly for Bombay. The expedition will be divided into two sections. While the scientists will remain around the snow-line with their base at Kashmir, the alpinists will attack unclimbed peaks of the Himalayas, including Mount Everest.

FINANCIAL needs of the Bureau of Mines of the Department of Commerce to enable a broader field of research were emphasized before the Senate Committee on Mines and Mining on February 15 by the director of the bureau, Mr. Scott Turner. The importance of the industry for which additional aid is asked was illustrated by Mr. Turner, who testified that gross mineral production in the United States in 1928 aggregated $5,400,000,000 as compared with $12,253,000,000 for agricultural products in the fiscal year 1928.

THE J. T. Baker Company, eastern division, has established a research fellowship in analytical chemistry of the value of $1,000 a year. A similar fellowship has been established by this company in the midwest and other sectional fellowships are contemplated. The committee of award is composed of Drs. N. Howell Furman, Princeton University, *chairman;* Philip E. Browning, Yale University, *secretary;* Gregory P. Baxter, Harvard University; E. M. Chamot, Cornell University; H. A. Fales, Columbia University.

EDWARD S. HARKNESS has made a gift of $150,000 to the Neurological Institute of New York City. The cost of completing and equipping the new building of the institute at the Medical Center has been $1,900,000, of which $300,000 remained to be raised when Mr. Harkness made his donation. The sum of $150,000 remains to be contributed before the opening of the center unit on full scale.

A GIFT of $480,000 for development of civil aviation in Chile has been made by Mr. Daniel Guggenheim.

AN insectary has recently been completed at Iowa State College, equipped with greenhouse facilities, screened out-door laboratory and underground laboratory for the study of subterranean insects. Among the studies which this new building is already making possible are researches on oil sprays and other insecticides, on the life history of stored grain insect pests, on the native corn borer, on onion pests and on truck garden and field pests.

UNIVERSITY AND EDUCATIONAL NOTES

THE University of California will receive a gift of approximately $140,000 from the estate of the late James Sutton, recorder of the institution for more than thirty-seven years. The will contains a provision that half of his estate shall go to the university, with no restrictions as to how it shall be used.

GIFTS of $2,000,000 from the General Education Board of New York and the Julius Rosenwald Fund of Chicago have been received by the Meharry Medical College, Nashville, for the establishment of an adequate school for the training of Negro physicians. A part of the project, to which alumni will contribute $200,000, will be a 120-bed hospital. There will be facilities for 200 students and departments of dentistry and pharmacy. The college was established in Nashville in 1876.

ASSEMBLYMAN JAMES R. ROBINSON, of Ithaca, has introduced a bill in the legislature providing $1,000,000 for the construction of a home economics building at Cornell University.

A BILL carrying an appropriation of $12,000,000 for the establishment of a national university, with an endowment fund of $60,000,000, as a memorial to George Washington, has been introduced in the House by Representative Guyer, Republican, of Kansas.

AT Stanford University, the following promotions to assistant professorships have been made: Albert Paul Krueger in bacteriology; George E. MacGinitie in zoology (Hopkins Marine Station); Victor Ernest Hall and John Field, 2d, in physiology; W. Bryan Duncan in electrical engineering, and John Kent Lewis in medicine.

DISCUSSION

BIOLOGICAL PUBLICATION IN AMERICA

ARE we not making a mistake in this country in the restrictions we have chosen or have allowed to be forced upon us in the publication of the results of biological research? We discourage the publication of comprehensive studies adequately illustrated and use our facilities for publication mostly for short papers with a minimum of pictorial illustration. It is not difficult to get one of our journals to publish a brief and scantly illustrated paper, but only very limited media are available for the presentation of monographic studies.

This policy tends toward the publication of research item by item, toward hasty publication of current work. Is it not a far sounder plan in general to hold back final publication of the several steps in the advancing research until one has obtained a somewhat broad grasp of the significance of many items and phases of the study, each seen in the light of the others?

The result is that some American biological research as published is not as maturely considered as it well might be. Many appearances may seem at first real which are shown to be false after more thorough consideration in the light of related phenomena. Hypotheses which seem to fit data at hand in early stages of an investigation are often, yes generally, shown by further study to require modification or very likely abandonment. We now encourage the rapid presentation of insufficiently considered results and place difficulty in the way of the student of sounder habit who chooses before publishing to ruminate over data gathered from a comprehensive study.

Our present tendency toward hasty publication is, to be sure, in line with the jazz spirit in art, literature and music, indeed in life itself, having at its root unwillingness to do prolonged and faithful work before seeking expression and advertisement. But can we afford in biological or any other science to follow unthinkingly a general plan of publication which tends toward unscholarly presentation of research?

There is a happy medium to be sought. Great delay in publication has its disadvantages and its dangers. An example of deplorable loss through delay in publication is seen in Professor Whitman's death before he had presented to the world the results of his many years of intense and ruminative study of pigeons, and of other subjects as well. Dr. Riddle has rescued much of this work and has thus placed biologists in deep debt to him. Yet, finely and sympathetically as this work has been done, we can not but miss Professor Whitman's own expression of his own thought with its individual flavor. Furthermore, in general, in cases in which final publication is reached, too long delay may not only deprive other workers of the chance to compare data but may deprive the delaying author of the benefit of criticism.

The formerly much used plan of preliminary notices secured many of the advantages of prompt publication, while not at all displacing later maturer presentation. Somewhat the same purposes are served by the ten- and fifteen-minute reports to the scientific societies and the published abstracts of these. Probably a somewhat more liberal allowance of space for the abstracts might in many cases let the author be content to delay final publication until a wider and more intensive study of the field has been had.

But where could he find publication for such a comprehensive paper as would finally result? Universities, local academies of science, the Carnegie Institution, some government agencies and some, like the Smithsonian Institution and the National Academy of Science, with government affiliation, publish long papers, but in general their presses are open only, or at least chiefly, to authors associated with the several institutions. They do something, enough to be really helpful, but not nearly enough to meet the need, not at all enough to relieve and change the present unfortunate trend toward brief and rapid publication in place of comprehensive monographic treatment.

Two other considerations seem to deserve emphasis: pictorial illustration, and profit by publishers upon scientific papers. Editors of our journals object to many illustrations. They cost more per square inch than does text. The tendency, therefore, is in favor of expressing an idea in words and against its expression in a picture. This is exactly wrong. Verbal presentation is less vivid, less accurate and less adequate than pictures for most descriptive phases of a subject. Give twenty competent artists a verbal description of a landscape, elaborate and accurate so far as it goes, and ask them to paint the landscape. The lack of agreement in the resulting pictures will be a fair index of the unsatisfactory character of verbal description without pictures in biological publication.

A word as to cost and financial profit. If the author receives little or usually no money for his research labors, why in the publication of the research is it appropriate to pay any money profit to a publisher? It would seem that all publications of scientific research should be sold at cost, no one, author or publisher, making any financial profit. The purchasers are largely research workers whose research labor is a gift to science. If there is to be any financial profit in publication of scientific research it might be given to the authors more appropriately than to the publishers. Probably complete divorcing of publication of scientific research from financial profit to any one, author or publisher, would prove most satisfactory, freeing the readers of research results from financial contribution above cost of publication and leaving all flavor of money reward out of the minds of those who do the research.

Small endowments or guarantee funds for such publication at cost would be needed as a safeguard against deficit. If the scientific societies might each have such a small publication fund, with enough in addition to pay for adequate clerical help to the

editors, most papers of ordinary character could be taken care of.

If the emphasis upon publication chiefly of brief papers were changed in favor of putting out more considered papers by each author at longer intervals, the total length of all the published papers would probably considerably decrease, for comparisons of an author's earlier data with those gathered later could be published once for all in the comprehensive paper rather than made item by item in the publication of a series of papers each making a minor contribution. There would be some saving also by eliminating a good bit of modification or withdrawal of earlier statements.

But there would still remain some papers whose greater length or abundant illustration or unusually expensive illustration would require publication apart from the regular journals. It is extremely difficult now to find publication for such papers, although they include a goodly proportion of our most valuable studies.

The whole subject of biological publication is now being considered. In this study there should be held in mind the influence which the character of the facilities for publication has upon the development of the science. American biology has suffered appreciably from a wrong influence in this matter, and is due to suffer still further unless the present trend is changed.

MAYNARD M. METCALF

WOODS HOLE, MASS.,
SEPTEMBER 14, 1928

EVOLUTION

THE essential features of the new concept of evolution recently proposed may be stated in a few words. It is rather a harmonizing of previous theories than a new idea; but parts of it are wholly new.

While the idea of linear evolution involving a time element is in general quite valid within restricted groups, as for instance in the vertebrates where it is well illustrated by the horses, yet it must undergo a certain modification, for gaps are found in all these evolutionary lines, and many of these gaps appear to be real—that is, they were never, so far as we have been able to learn, bridged by so-called missing links. To take a concrete example, it is quite obvious that the gap between cats and dogs is broad, and it remains broad throughout the fossil record. Cats never became dogs, nor dogs cats; but both are carnivorous mammals.

Between the backboned animals and the invertebrates the gaps are very wide, and those peculiar types which are intermediate between them are widely different from either.

Between the various invertebrate groups, as the arthropods, echinoderms, nemerteans, and so forth, the gaps are still wider. Indeed, so broad are the gaps between these various types of lower animals that they can not be arranged in any sort of evolutionary line. But they do seem to fit perfectly well into a somewhat complicated figure,[1] showing each to have affinities with several others, not merely with a single one.

The gaps between the various invertebrate phyla go back quite unchanged to the very earliest fossils that are adequately known, those of Cambrian time.

It is undoubtedly true that the Cambrian is much nearer to the present time than it is to the far distant past when life on earth began, so that conditions in the Cambrian are not necessarily those at the time of the origin of life.

But the complexity of the intricate interrelationships between the various phyla at the present day suggests an evolutionary picture of quite a different sort from that indicated by the interrelationships of the forms included within each phylum.

While the developmental lines included within the phyla as we know them (as, for instance, the line tracing the horses from the generalized pygmy type of the Eocene to the large highly specialized types of the present day) involve a time element, the evolutionary scheme by which the phyla themselves are interconnected (see reference cited above) does not. So it is assumed that in so far as the phyla or major groups of animals are concerned life from the very first presented the same essential features that it does to-day.

With this hypothesis both the conditions in the Cambrian and the subsequent changes from horizon to horizon in the time between the Cambrian and the present are in agreement.

AUSTIN H. CLARK

U. S. NATIONAL MUSEUM

AMIA FROM THE CRETACEOUS

A YEAR ago I received from Edward M. Kindle, paleontologist of Canada, a number of small fragments of the skull of a little fish, found in evaporated Cretaceous ponds in Alberta, Canada. Among these fragments were no traces of skeleton or fins. These I described in the *Canadian Field Naturalist*, under the name of *Kindleia fragosa*. I was mistaken in regarding these as a Cichlid fish. It appears to belong to the group of Amiids.

I have the following valuable note from Dr. Errol I. White, now in charge of the recent fossils in the

[1] *Journ.* Washington Acad. Sci., Vol. 13, No. 7, April 4, 1923, pp. 129–138.

British Museum. In a private letter he writes me:

"I hope you will not mind my pointing out that the remains figured are those of a very typical species of *Amia*, and that the 'united lower pharyngeals' are the vomers, and the 'pre-maxillae' are maxillae. As far as I know this is the first American record of *Amia* from the Cretaceous and there is only one pre-Tertiary European species, *A. prisca* (R. Kner). See A. S. Woodward, 1901, Cat. Foss. Fishes Brit. Mus., pt. iv, p. 371, bottom."

My description was in *Canadian Field Naturalist*, XLI, October, 1927, pp. 145–7.

DAVID STARR JORDAN

MISUSE OF SCIENTIFIC REFERENCES IN COMMERCIAL ADVERTISING

IN the current candy-cigarette war for the control of actresses' testimonials and the trade of the public, the National Confectioners Association, through its research department, in an advertisement published in the *Saturday Evening Post* of January 19, has hit upon the happy idea of misusing the oft-quoted phrase "fats burn in the flame of carbohydrates." This phrase is ordinarily taken to describe picturesquely a relationship in the intermediary metabolism of these two groups of foodstuffs. By the use of asterisks, one specifically in regard to the above phrase, in an unauthorized reference to my text-book, it is made to appear that scientific workers have given their advice to fat people to eat candy and grow thin.

M. BODANSKY

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SCHOOL OF MEDICINE

IMPORTATION OF CINEMATOGRAPHIC FILMS

As the result of the difficulty and cost of sending a film to England last summer to be presented before the British Association of Anatomists, the House of Commons, on July 23, 1928, passed a clause exempting scientific films from customs duty in England and Northern Ireland. The new clause reads as follows:

"(1) The customs duties imposed by Subsection 1 of Section III of the Finance Act, 1925, on negative and positive films shall cease to be payable in the case of a film which is certified by the Royal Society of London for promoting natural knowledge to be solely an illustration of scientific investigation for exhibition before members of a recognized scientific body and which is imported only for the purpose of such exhibition free of duty.

"(2) If any person exhibits otherwise than as aforesaid any film which has been exempted from duty under this section he shall on summary conviction be liable in respect of each offense to a fine not exceeding fifty pounds."

In regard to the importation of films into this country, the assistant collector, U. S. Customs Service, Baltimore, Md., informs me "That the Treasury Department has ruled that cinematograph films may be imported free of duty by any society or institution incorporated or established solely for religious, philosophical, educational, scientific or literary purposes, for its own use or for the encouragement of the fine arts and not for sale, otherwise they would be dutiable under Paragraph 1453 of the present Tariff Act."

WARREN H. LEWIS

THE JOHNS HOPKINS UNIVERSITY

REPLY TO PROFESSOR WILLCOX

IN his article in SCIENCE for February 8, 1929, pages 163–165, Professor W. F. Willcox simply repeats erroneous mathematical statements the falsity of which had already been called to his attention. (See SCIENCE, December 14, 1928.)

Professor Willcox contends that the choice between "equal proportions" and "major fractions" is a political and not a mathematical problem. His arguments, however, are mathematical, and involve crass misstatements of the mathematical facts.

For example, the statement on page 164 that a certain series of quotients "would sum up to 435" is false. Again, on page 165 the statement that the "method of minimum range" is the same as the "method of the harmonic mean" is false. Again, his whole description of the method of equal proportions is grotesque.

Is it any wonder that he thinks it "undesirable" to request "a report on the mathematical facts" from a competent body of scholars?

It appears to be only by evasive and misleading arguments like these that the method of major fractions can be defended.

EDWARD V. HUNTINGTON

HARVARD UNIVERSITY

SPECIAL CORRESPONDENCE

GEOLOGICAL WORK IN TONGA AND FIJI

GEOLOGICAL work in Tonga and Fiji under the auspices of the Bishop Museum and Yale University was begun in 1926 when the writers spent several months in these islands. At this time Hoffmeister devoted his attention to Eua and Tongatabu, the southernmost islands of Tonga, while Ladd carried on similar work in Vitilevu, the largest island of Fiji. In April of last year the investigations were resumed for a period of four months.

During the first month Ladd cooperated with Hoffmeister in Tonga and the work on Eua and Tongatabu was completed. In addition a trip was made to Falcon Island, a recently emerged volcanic cone which lies fifty miles north-northwest of Tongatabu. A landing was made under difficult conditions. The island is two miles in diameter and is composed entirely of pyroclastic materials, chiefly scoria and ash. The crater is located on the southeastern side and is occupied by a boiling lake whose waters rise and fall with the tide. Large quantities of steam and sulphurous gases arise from the crater. The crater walls are highest to leeward where they reach an elevation of 365 feet.

Ladd returned to Fiji to continue his study of Vitilevu, while Hoffmeister spent the next two months in the Vavau group at the northern end of Tonga. During the fourth month Hoffmeister joined Ladd on Vitilevu and the survey of this island was completed.

The island of Vavau is made entirely of limestone. Coral limestone predominates along the whole border of the island with the exception of the southern side. The rocks of the latter side and also of the interior seem to be made mainly of foraminifera. This side is characterized by long, deep arms of the sea which run inland in a general north-south direction and which are separated by narrow strips of land. These deep bays were formed by solution of the soft, porous limestone at the time the island stood considerably higher than it does at present. At this time they took the shape of enormous sink holes. Following this, submergence took place so that all but the highest parts of the island were covered by water. Since then elevation has progressed in stages to form clearly defined terraces. During all this time the sea, aided by the strong trade winds, had been cutting deeply into the limestone on the south and southeastern sides. In some places the southern rims of the sink holes were cut through and the latter were turned into bays. Although no detailed study of the rocks has been made it seems very probable that Vavau is considerably younger than the island of Eua. The latter has been found to contain some Eocene rocks and is beyond much doubt the oldest island of Tonga.

A large part of the 1928 field season was devoted to a study of the structural geology of Vitilevu. It seems clear that faulting has played a very important rôle in the history of the island. It is responsible for numerous topographic features, has determined the main drainage lines and is believed to be the mechanism by which Vitilevu was severed from a much larger land mass that extended to the west. Rarely do the rocks of Vitilevu exhibit folding. High dips are local and usually are definitely related to fault lines.

The more important steps in the geological history of Vitilevu seem to be as follows:

(1) The formation of a series of ancient volcanics and sediments.

(2) Mountain building and the intrusion of plutonics. This event occurred at least as early as Cretaceous time.

(3) Prolonged erosion which removed most of the older rock and exposed the plutonics over wide areas.

(4) Submergence, probably by faulting, at the beginning of the Miocene. It was at this time that Fiji's continental connection was lost. Apparently very little of Vitilevu showed above water.

(5) Extrusive vulcanism—tuffs, marls and flows. Lower Miocene.

(6) Cessation of vulcanism and widespread deposition of foraminiferal limestone to depth of several hundred feet. Lower Miocene.

(7) Uplift by block faulting with the extrusion of volcanic materials along major fault planes. The older volcanics and the limestone were much fractured by this faulting. Some of the fault blocks were elevated three thousand feet. Most of the volcanic material was ejected as agglomerate, which was reworked to form tuffs, marls and conglomerates. Locally small amounts of foraminiferal or coralliferous limestone were formed. Miocene to near Recent.

(8) Development of present topography and modern reef building. Minor faulting.

H. S. LADD
UNIVERSITY OF VIRGINIA

J. E. HOFFMEISTER
UNIVERSITY OF ROCHESTER

SCIENTIFIC BOOKS

Our Federal Lands. By ROBERT STERLING YARD, Executive Secretary, National Parks Association. Illustrated. New York. Charles Scribner's Sons. $5.00.

"WE are admittedly the richest, most powerful nation in the world and we took this power of wealth out of the ground. Now, we must invoice our resources and determine how we should proceed from here. For a nation begins but once," writes Dr. Hubert Work, secretary of the interior, in closing a brief and striking foreword to this remarkable book. Remarkable truly since no one heretofore has ever essayed the task of describing and inventorying the extensive and varied territory which the author has brought together under the new and inclusive term of "Our Federal Lands." No one who scans even superficially the pages of this work can fail to be impressed that in these lands the United States has

an "empire of famous history, vast size, colossal wealth, unbelievable opportunity, intricate problems, and physical beauty and diversity beyond imagination."

Each of the ten chapters deals with a particular type of the national area, recounting its history, origin, development, magnitude, utilization, political and social exploitation and pointing out its future significance in the upbuilding of the nation. Not a problem in conservation but finds its past and its future inseparably connected with some area of the federal lands and the policies for their control and utilization.

The first chapter on "Our National Estate" sketches in rapid outline the extent and diversity of these possessions, their value in the early years of national history as a source of revenue, and the origin of national movements which have grown out of them. Last and greatest of these movements is that embodied in the National Conference on Outdoor Recreation, called by President Coolidge four years ago and destined to be an outstanding contribution of his administration to the social invigoration of the American people through perpetuation of the contact with nature which had played such a signal part in molding the spirit of the pioneers.

The story of the public domain which follows, portrays the building of the nation, the rapid outflow of population under the enticement of free homesteads, the building of the railroads, the differentiation of mineral lands, timber lands, water-power lands and reclamation areas, with the complex legal and administration problems growing out of them. While in a real sense Roosevelt established for us the policy of the conservation of natural resources, yet, as Yard points out, the principle was recognized in royal charters of the colonies. It was Roosevelt who led the public revolt against wide-spread looting of national property by local and private interests. An interesting section here deals with the era of the automobile and the profound changes it has wrought in the problems of the federal lands.

The story of "Our National Forests" which constitutes the third chapter begins with a vivid description of the primitive conditions and traces the transformation of vast forested areas into rich, well-populated agricultural lands. From 1870 on came an orgy of forest destruction that transferred immense wealth to speculators and land grabbers and forced upon public attention the absolute necessity of forest conservation. To be sure isolated warnings had been uttered by individuals, and in 1873 the American Association for the Advancement of Science memorialized Congress and state legislatures for forest protection. This dates the start of the popular movement; yet it was 1891 before the Forest Reserve Act was adopted and then only as a rider on a conference bill. When ten years later Theodore Roosevelt became president he put his full power behind the weak and inadequately manned Bureau of Forestry with generally recognized and conspicuous success. Roosevelt also established our water-power policy. The recreational use of national forests, the popular demand for wilderness areas and the preservation of wild life were natural outgrowths of the forest policy of Roosevelt and his successors.

A similarly intriguing chapter is that on reclaiming the desert. The story is followed out in historical sequence. It started with the National Irrigation Congress in 1901 and the Reclamation Act signed by President Roosevelt in 1902. To-day despite reverses and local setbacks this looms larger as a national enterprise than it did twenty-seven years ago. Akin to the irrigation of arid areas in the west is the reclamation of half a billion acres depleted by wasteful farming in the east. Valuable and extensive technical data are presented in tables, thus obviating breaks in the story itself and lightening the text to a large extent at least of a forbidding load of figures.

Water-power in the United States, estimated at fifty million horse-power of which only thirty million is commercially available and about twelve million is already developed, occupies a conspicuous place to-day in public attention. Federal control over it rests in considerable degree on its source in federal lands. Unfortunately the development of hydroelectric plants in some places threatens the existence of valuable fish resources and in other regions at times increases the pollution menace. Time and proper attention will solve these difficulties. In a few instances and at the hands of selfish promoters water-power development has threatened the national parks, those unique areas consecrated for all times to the people and as such to be zealously guarded.

The chapter on "Our Indian Wards" will be full of surprises to the reader. This is not a dying race but a people rapidly increasing in numbers and probably prosperous enough to be rated the richest nation on the face of the globe. As the data have come from government sources and the text has been revised by government officials the story told here is undoubtedly conservative, but it is not creditable to a great and rich nation and will be a surprise to some of our fellow citizens. Land hunger in earlier days has been followed by land grabbing with deceit and theft that has diverted areas of great value from those legally recognized as the lawful owners. Important problems in conservation are handled in this connection and in a calm, concise and clear manner that will appeal to the thoughtful reader.

Those who know Mr. Yard's able services as secretary of the National Parks Association and his valuable books on national parks will look to the chapter on that topic for the last word on the subject and will not be disappointed. It presents the best and most complete picture of the situation yet given. The standards, history, uses and development of national parks, the attacks upon the system and its public value are discussed with a frankness and breadth of view that make the account of special value just at this time when so many proposals for new projects mostly of local worth are being insistently urged upon the attention of Congress and the American people.

The chapter on "National Monuments" brings up another type of land area not clearly defined in the public mind and points out the need of study to formulate a proper system for the development of all such areas and a plan for the protection of each type so that its fundamental purpose may be most fully realized. Certain areas now labeled national parks certainly do not meet appropriate standards as such. National monuments have clearly a different character and purpose. And there are some areas not possessing the qualities of either group that are undoubtedly worth setting apart for the use of the people as recreational areas in which far greater freedom of action may be allowed the public without endangering their value than is possible in national parks or national monuments. National parks are discussed under Merriam's apt designation as a super-university of nature; national monuments constitute a lesser outdoor national museum; recreational areas provide the nation's playground. The account sets forth well the part played by different agencies, including the American Association for the Advancement of Science together with various other organizations, in formulating and establishing these standards first enunciated by distinguished leaders in public life. Despite what has been done, the system is still imperfect, and conflicting views between different government bureaus and departments need definite and early adjustment in the public interest. The reading of Mr. Yard's book shows clearly the heterogeneous character of the areas grouped under these headings and the dangers impending in the near future if readjustments are not made.

Another and pressing aspect of the situation is brought out vividly in the chapter on the "Depletion and Rescue of Our Amazing Heritage of Wild Life." The formation of refuges, which must be extended greatly in the immediate future, introduces a type of wilderness area demanding new methods of selection and maintenance. The movement for such refuges is very new but its influence has grown powerful within a brief period. It can not be overlooked in the necessary and impending coordination of government areas and the development of conservation policies.

In the last chapter on "Half a Century of Nature Conservation," the author has brought out the essential character of the movement which led to the National Conference on Outdoor Recreation, called by President Coolidge in 1924, and the new era which was ushered in thereby. Roosevelt laid the foundations of the conservation movement; Coolidge built the first story. It remains for the future to complete the structure. Yard points out here with vividness lines of future growth and future danger.

The book has covered a large and unbroken field with success. It is readable and dependable despite the inclusion of a few errors. It is well printed and beautifully illustrated by fifty well-chosen full-page plates. Another edition will devote more space to wild life and its protection, a topic which, left to the end, was cut off somewhat abruptly in comparison with other chapters.

There is especial reason to read the book now when shrewd politicians and promoters are bombarding Congress with schemes for "utilizing" national resources, creating a dozen new national parks mostly as amusement resorts for local gain, and consenting sacrificially to use parts of old parks for the good of the people, or their part of it. Remember that these lands are "Our Federal Lands," and should be preserved both from expropriation and from despoliation. This can not be done unless the problem is understood and the work carried out intelligently. Mr. Yard has done the nation a great service in his long and exhaustive study of the situation and in his clear and effective presentation of the facts in this volume. To keep these lands for the people is the problem of to-day.

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Pflanzensoziologie; Grundzüge der Vegetationskunde. By DR. J. BRAUN-BLANQUET. Mit 168 Abbildungen und 330 Seiten. Biologische Studienbücher VII. Herausgegeben von Walther Schoeninchen, Berlin. 1928.

THE author, who is connected with the botanical institute of the University of Montpellier in southern France, has had unusual experience in the study of vegetation from the modern ecological standpoint. He puts together in attractive and readable form the results of his own work, as well as those of his ecological colleagues the world over. The book shows that the author has kept intimately in touch with the advances made in the particular field of botany covered by the text.

The preface describes the place occupied by plant sociology in the biological system. Section one, part 1, deals with the principles underlying the grouping of plants into societies, the commensal life of plants, their struggle for existence and similar matters. The second section gives in detail the methods adopted by the ecologist in the investigation of vegetation. Part 2 of this section treats of the climatic factors, such as heat, light, water, wind, soil (chemical and physical characters), relief, the influence of man and animals and life forms.

The third part considers in detail the development of vegetation complexes, the methods of their study, their classification; while the fourth part in twenty pages describes the geographical distribution of vegetation as to zonation, pioneer and relict groups, regions, provinces, districts, etc. Part 5 is devoted to the distribution and arrangement of the plant associations (association systems). The photographs, graphs and line drawings used to illustrate the book are new and well chosen.

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REPORTS

VITAMIN B TERMINOLOGY

IN SCIENCE of August 31, 1928 (Vol. 68, No. 1757, pages 206–209) was published a summary of the various proposed systems of vitamin B terminology then under consideration by the committee on vitamin B nomenclature of the American Society of Biological Chemists.

The various proposed systems of terminology eventually narrowed down to three, which seemed in the minds of the committee to be most likely to satisfy the majority of workers in the field of vitamin research.

Summarized briefly, the three systems of terminology were as follows:

(1) *The British suggestions.* The British investigators recommended, as a temporary expedient, that the letter "B" be used to designate the complex, "B_1" to identify the heat-labile factor, and "B_2" to refer to the heat-stable factor or factors.

(2) *The Sherman suggestions.* Dr. Sherman suggested that the term "B" be used to refer to the complex with the hope that it would eventually receive "honorable retirement" and that the letters "F" and "G" be used in a permanent system of nomenclature, in place of "B_1" and "B_2," respectively, which had been adopted as temporary terms by British workers.

(3) *The McCollum suggestions.* Dr. McCollum, for reasons enumerated in the former committee report, suggested that the term "B" be retained but restricted to refer to the heat-labile factor, and that Sherman's "G" be used to designate the more heat-stable factor.

After considerable correspondence the committee have voted to make the following recommendations:

(1) That the term "Bios," as suggested by the British workers, be retained to denote the factor or factors encouraging the rapid growth of yeast cells.

(2) That the term "B" be restricted to designate the more heat-labile (antineuritic) factor.

(3) That the term "G" be used to denote the more heat-stable, water-soluble, dietary factor, called the P-P (pellagra-preventive) factor by Goldberger and associates, and which also has to do with maintenance and growth.

(4) That the naming of newly discovered dietary factors, by other than descriptive terms, should be discouraged until their identity is established beyond question.

(5) That a committee on vitamin nomenclature be appointed by the American Society of Biological Chemists and that this committee, in cooperation with the British committee and similar committees on the continent, endeavor to act as a clearing-house for questions in vitamin terminology, and that this committee be empowered to name new factors when their identity is established.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED METHOD FOR SEALING MICROSCOPIC MOUNTS

THE preparation of biological material as permanent microscopic mounts in certain fluid media is of very general interest. None is more desirous of such permanence than the taxonomist, to whom microscopic characters are of prime importance. The slow and laborious processes commonly used are so unsatisfactory that the writer feels justified in presenting a new method thought to possess certain advantages. This method is described after a short review of some current practices. The subject is considered from the viewpoint of the herbarium mycologist but has also a more general application.

A proper comparison of any specimens in a mycological herbarium requires detailed microscopic ex-

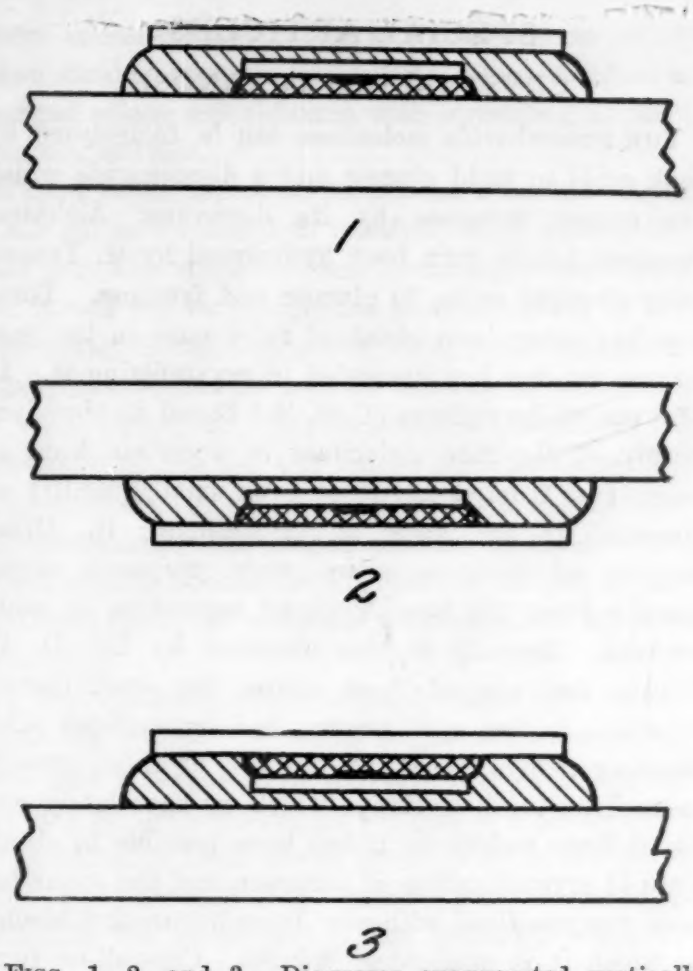
amination, involving the excision of part of the material itself. The specimen utilized is often so fragmentary that after a period of years during which successive preparations have been made it is exhausted and consequently useless. As a protection against such abuse and exhaustion it is a recognized practice to attempt to preserve any preparations made from specimens of particular significance. The technique is naturally variable according to the exigencies of the case and the traditions of the institution.

Permanent mounts in Canada balsam and other materials accomplished by such means as the paraffin embedding method are, of course, essential to certain work but are too complicated and time consuming for ordinary herbarium use. They are furthermore all too often less valuable due to the resultant uncertain optical quality than preparations in an aqueous medium.

A simple preparation is a mount in water under a cover-glass attached at different points on the margin to the slide by pieces of gummed paper or gummed cloth or by drops of balsam. After drying this can be flooded again by a drop of water and is therefore more or less permanent. This method is fairly satisfactory for the preservation of mounts of large spores, but has obvious limitations.

Simple mounts in glycerine jelly and in various media with a glycerine base are generally familiar. To prevent destruction from drying and rough handling the time-honored method is that of sealing the mount at the border of the cover-glass with a ring of Canada balsam, gold-size, various cements, lacquers or similar materials. Ringing, although seemingly a simple process, really requires delicate manipulation. Ring seals have been kept more or less intact for years, but usually only after repeated inspection and repairs, all too often the ring eventually cracking or becoming detached at some point with consequent uneven adhesion and loss of the seal.

A protective seal has been devised whereby the ordinary balsam-ring is covered when fresh by a large cover-glass; *i.e.*, after the usual cover-glass is in place it is covered by a drop of Canada balsam of suitable size and consistency, so that a second cover-glass of greater diameter superimposed will allow the balsam to form a ring about the first cover and under the second cover with but a very thin balsam film between (Fig. 1). This process as used for several years by the writer has been uniformly successful in the making of relatively permanent mounts in glycerine jelly and in various mounting fields. It has, however, a decided disadvantage in that even when using thin cover-glasses, No. 0, they, plus the thinnest intermediate balsam film, make so thick a composite cover



FIGS. 1, 2, and 3.—Diagrams exaggerated vertically to illustrate vertical sections through microscopic preparations; clear is used to represent glass, double cross hatching for the mounting medium and single cross hatching for the balsam seal.

that microscopic examination with the high-power lens combination is feasible only with objectives of relatively great working distance, precluding the use of all oil immersion and of some dry objectives. A modification or rather reverse manipulation of the method, wherein this disadvantage is eliminated permitting commonly the use of less fragile cover-glasses as well as requiring less delicate manipulation, is outlined below:

Place a drop of the mounting medium in the center of a large cover-glass preferably of 22 mm diameter, and orient the objects in the medium. Cover the mount with a smaller cover-glass, preferably of 12 mm diameter; if the medium is fluid and in excess draw off the surplus with a blotter. Over this place a large drop of fluid Canada balsam. Cover gently with a slide (Fig. 2) until the smaller cover-glass and the mount are surrounded by a ring of balsam and the balsam also covers the exposed under surface of the large cover-glass. The slide is then inverted (Fig. 3) revealing the microscopic mount under the one cover-glass and surrounded by a protected balsam seal.

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SPECIAL ARTICLES

CRYSTALLINE TURANOSE

THE trisaccharide melezitose can be hydrolyzed by weak acids to yield glucose and a disaccharide which was named turanose by its discoverer Alekhine. Turanose has in turn been hydrolyzed by G. Tanret, using stronger acids, to glucose and fructose. Turanose has never been obtained fully pure in the past because no one has succeeded in crystallizing it. In 1918 one of the authors (C. S. H.) found an abundant supply of the rare melezitose in a certain kind of honey and from it he prepared a small quantity of turanose in the hope of crystallizing it. Other samples of turanose sirup were prepared subsequently from this same stock of melezitose by other workers. Recently it was observed by Dr. D. H. Brauns that one of these sirups, the exact history of which is not now known, had crystallized after standing many years. By the use of these crystals to nucleate turanose sirups which we have lately prepared from melezitose it has been possible to obtain a rapid crystallization of turanose and the sugar has been recrystallized with ease from hot methyl alcohol in which it is moderately soluble. Crystalline turanose on solution in water shows a large and rapid mutarotation. At 20° the rotation of its freshly prepared aqueous solution three minutes after dissolving, was approximately $[\alpha]\frac{20}{D} = +43.5$ and the value became constant within 20 minutes at about $[\alpha]\frac{20}{D} = +75.6$. Crystalline turanose is thus a beta form of the sugar. The crystals are well-formed prisms with many faces developed. The sugar possesses a sweet flavor. Its melting point is 157°. A study of this interesting disaccharide, which can now be obtained in pure condition, has been undertaken.

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THE pH OF THE WHITE AS AN IMPORTANT FACTOR INFLUENCING THE KEEPING QUALITY OF HENS' EGGS[1]

HENS' eggs which are heavily infected with micro-organisms ordinarily have very poor keeping qualities. Several bacteriological investigations, the results of which appear in the literature, indicate that only a very small percentage of the freshly laid eggs contain bacteria. If a great number of eggs are shown to be heavily infected with bacteria after storage, improper treatment after the eggs were laid is indicated. However, eggs in the shell deteriorate in storage, but the presence of micro-organisms can not be demonstrated, therefore other factors besides micro-organisms must also be responsible for egg deterioration.

It is customary in grading eggs in the shell to consider the size of the air cell as one of the important factors indicating the quality of the egg, since the size of the air cell increases after the egg is stored, due to the evaporation of water from the egg. If the size of the air cell alone is used as the basis for estimating the interior quality of the egg, very erroneous conclusions may be drawn, since the size of the air cell is dependent upon the relative humidity of the atmosphere in which the egg is kept and upon the temperature. At the present time it is possible, by proper control of the temperature, circulation and humidity of the air in the storage room, to decrease the loss of water from the eggs to a very small amount.

Other changes take place in the eggs during storage which are more detrimental than the loss of water. Three of these changes which are probably the most important are: (1) The change of the thick jelly-like white which surrounds the yolk of the egg to a fluid condition, producing what is commonly called "watery whites." (2) The passage of water from the white to the yolk, producing a more fluid condition of the yolk contents. (3) The weakening of the yolk membrane, causing the yolk of the egg to flatten when the egg is broken, and, if this weakening has progressed far enough, to break.

Greenlee[2] has previously called attention to the passage of water from the white to the yolk as one of the changes taking place in eggs in storage.

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[1] This is a preliminary note summarizing some of the results obtained in an investigation suggested by Dr. C. K. Powell, of the poultry department at Cornell University, and began with his cooperation. He was forced to drop out of the project about two years ago and since then the investigation has been continued. Drs. R. Whitaker, C. N. Stark and R. L. Bryant have helped with certain phases of the investigation, and valuable technical assistance has been rendered by Mr. A. E. Everhart, of the poultry department. Experimental evidence for the statements made will be published later.

This report will naturally raise the question as to the effect of the control of the pH of the white on the growth of the chicken embryo during incubation. Experimental work on this effect was begun in 1925 with the cooperation of Dr. C. K. Powell and is still being continued.

[2] A. D. Greenlee, "Deterioration of Eggs as Shown by Changes in Moisture Content," U. S. D. A. Bu. Chem. Circ. No. 83. 1911.

It has been found by Healy and Peter[3] and independently by Sharp and Powell[4] that as soon as the egg is laid the pH of the white begins to increase, due to the loss of carbon dioxide. Actually this change in pH may be from about 7.6, the pH of the white of a fresh egg, to 9.7. This means an increase in alkalinity of approximately one hundred times. The yolk of the fresh egg (1:1 dilution) has a pH of about 6.0. It also increases in pH during storage until a value of about 6.8 may be reached after long periods. The yolk, however, changes in pH more slowly than does the white. The increase in pH of the yolk is due to a loss of carbon dioxide from the yolk to the white which in turn loses it to the surrounding air.

Since it is known that the decomposition of other proteins is accelerated by high pH values, it seems only reasonable to suppose that the high pH of the white would be a factor in hastening the deterioration of the egg contents. Such was actually found to be the case. If eggs are stored in ordinary air, the pH of the egg contents rises and the three deterioration factors noted above are accelerated by this relatively high pH. This alkalinity can be easily and conveniently neutralized and controlled by placing the eggs in atmospheres containing small amounts of carbon dioxide. Carbon dioxide is taken up by the egg to establish an equilibrium between the concentration of carbon dioxide in the egg and in the air. Some of the carbon dioxide taken up by the egg, in the presence of the water, forms carbonic acid which neutralizes a proportionate amount of the alkalinity. By the use of proper concentrations of carbon dioxide the egg can be restored to and maintained at the same reaction it had when laid, that is, at more nearly the condition of the fresh egg. By so doing the deterioration of the egg is markedly retarded. The deterioration factor which is most readily correlated with the pH of the white is the "standing up" quality of the yolk as indicating the weakening and change in permeability of the yolk membrane. This factor may be readily expressed in numerical terms as the quotient of the height divided by the width, measured under controlled conditions. The keeping quality of the yolk of the egg improves as the carbon dioxide content of the atmosphere in which the egg is kept increases, except that in the higher ranges of carbon dioxide concentration relatively unrecognizable beneficial effects are obtained with increasing amount of carbon dioxide.

Watery white seems to be produced in two ways. As the pH is increased to relatively high values, the whole jelly-like white becomes increasingly more fluid until it can not be recognized as thick white at all. At relatively low pH values the thick white maintains its jelly-like properties but the amount of this jelly-like white decreases. This decrease in the amount of thick white at the low pH values may be caused by the precipitation of a protein in the thick white under such conditions. The largest amount of thick white of good quality is obtained at intermediate pH values and consequently at moderate concentrations of carbon dioxide.

At the relatively high concentrations of carbon dioxide the pH of the white is lowered to such an extent that a marked turbidity appears in the thick white due to the lowering of the pH to a point near the isoelectric point of one of the proteins of the thick white. This indicates the localization of the egg globulin in the thick white. The turbidity which is produced in the thick white by high concentrations of carbon dioxide can be made to disappear if some of the carbon dioxide is allowed to escape. This causes the pH to rise and the precipitated protein goes back into solution.

The concentration of carbon dioxide necessary in the atmosphere to hold the white at a pH corresponding approximately to that of a fresh egg lessens as the temperature decreases. At room temperature it takes approximately 10 to 12 per cent. of carbon dioxide in the atmosphere to hold the white at pH 7.6, while at near the freezing temperature about 3 per cent. of carbon dioxide in the atmosphere will accomplish the same purpose.

If the eggs, soon after they are laid, are placed in storage, in a carbon dioxide tight container in which the eggs occupy a relatively large part of the space, and if the humidity is properly controlled, the eggs will give up carbon dioxide to the atmosphere until the carbon dioxide in the atmosphere is in equilibrium with that in the eggs. This prevents the pH from increasing as much as it otherwise would and consequently exerts some preserving effect. Since the carbon dioxide escapes from the eggs so rapidly, the amount of carbon dioxide which the eggs contain by the time they reach the storage plant is sufficient to exert only a slight, but nevertheless recognizable preserving effect.

The importance of the alkalinity of the white as a factor in controlling egg deterioration has not pre-

[3] D. J. Healy, and A. M. Peter. "The Hydrogen-ion Concentration and Basicity of Egg Yolk and Egg White," *Amer. Jour. Physiol.*, 74: 363–368. 1925.

[4] P. F. Sharp, and C. K. Powell. "Physico-chemical Factors Influencing the Keeping Quality of Hens' Eggs in Storage," Proc. World's Poultry Congress. Ottawa, Canada. pp. 399–402. 1927.

viously been recognized, although the use of high concentrations of carbon dioxide (90 per cent. up to several atmospheres pressure) has been recommended for the preservation and sterilization (destroying micro-organisms) of eggs.

The lowering of the pH by using small amounts of carbon dioxide as recommended here would actually adjust the egg white to a pH more suitable for bacterial growth as shown by the experiments of Sharp and Whitaker,[5] Stark and Sharp[6] and Bryant and Sharp,[7] but if the eggs are properly cared for the deterioration due to bacteria is of minor importance and occurs in only a relatively few eggs.

The adjustment of the pH of the egg contents by means of carbon dioxide is of great practical importance since a relatively small amount of carbon dioxide in an air atmosphere will markedly retard deteriorative changes. The carbon dioxide produces markedly beneficial results at any temperature to which the eggs are subjected, proportionately greater amounts of carbon dioxide being required at the higher temperatures, and proportionately greater benefits being obtained. Carbon dioxide can be introduced into the air atmosphere of cold storage rooms in concentrations which greatly retard the destructive changes in the eggs, and yet the concentration will not be so high as to prevent workmen from entering the storage rooms.

The introduction of carbon dioxide into the air of shipping containers, refrigerator cars and the like can be used to retard deterioration.

Carbon dioxide tight containers, storage rooms and the like, although in some cases desirable, are not necessary since the carbon dioxide which escapes may be easily and cheaply replaced by the introduction of more. Carbon dioxide from any convenient source can be utilized, such as in the solid form or from cylinders. Solid carbon dioxide might be used in shipping eggs to serve the double purpose of keeping the eggs cold and holding the pH down, provided conditions were so regulated that the eggs did not freeze.

It has been estimated that if enough carbon dioxide were added to a storage room once each week for six months to give a concentration in the atmosphere of one per cent., the cost of the carbon dioxide would be less than one cent per case of eggs, or less than 0.03 cents per dozen. It would, however, be necessary to replenish the carbon dioxide more often, unless the walls of the storage room were so treated as to make them more impermeable to carbon dioxide.

The only method that approaches the one here described in cheapness and practicability is the oil dipping method, in which eggs are dipped for a short time in a suitable oil which very nearly seals the pores, and the eggs are then stored. The oil dipping largely prevents the loss of moisture and very materially slows down the rate of the loss of carbon dioxide. If the eggs are oil dipped as soon as they are laid, the preserving effect of a low pH is obtained, but the thick white becomes turbid during storage. If a considerable part of the carbon dioxide which was originally present in the eggs is allowed to escape before the eggs are dipped, then the turbidity of the white may be avoided, but the full preserving effect of the low pH is not obtained. Some carbon dioxide will diffuse from the yolk to the white after the eggs are dipped so that the pH of the white is somewhat lower than if the eggs were not oil dipped. If it is desired to oil dip eggs in which the pH has risen and obtain the full preserving effect of the low pH, all that is necessary is to place the eggs in an atmosphere containing sufficient carbon dioxide to lower the pH to the point desired, and then dip the eggs. If eggs which are not oil dipped are maintained in an atmosphere containing sufficient carbon dioxide to hold the pH down to near that of fresh egg white, a turbidity also appears in the white, but this turbidity disappears when the eggs are removed from the carbon dioxide atmosphere and some of the carbon dioxide is allowed to escape.

A number of household and commercial methods of preserving eggs in the shell have been studied with the introduction of many variables which might possibly influence the interior quality of the eggs at the end of the storage period. The results in all cases have been entirely consistent in indicating that the changes in the quality of the eggs during the storage period are dependent upon the effect of the following factors: (1) micro-organisms, (2) quality of the fresh eggs, (3) temperature, (4) passage of undesirable odors and flavors into the egg, (5) loss of water from the egg, and (6) the pH of the egg contents. The possibility of the control of the pH of the egg contents as a factor in egg preservation has apparently not previously been considered, and yet our experiments have shown that it ranks among the first in importance.

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[5] P. F. Sharp, and R. Whitaker. "The Relation of the Hydrogen-ion Concentration of Egg White to its Germicidal Action," *Jour. Bact.*, 14: 17–46. 1927.

[6] C. N. Stark, and P. F. Sharp. "The Relation Between the Hydrogen-ion Concentration of Egg White and the Growth of Anaerobes," *Jour. Bact.*, 13: 59–60. 1927.

[7] R. L. Bryant, and P. F. Sharp. Unpublished.